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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Part Time Education or Raising the Age

In 1918 it was made compulsory for young people engaged in industry to attend a continuation school between the ages of 14 and 18. The Act was never put into force, and there are many reasons whereby such an arrangement would be extremely awkward to employers. At the same time, some far-sighted people rather regretted this, because they felt that it would strengthen the hands of those who agitate for the raising of the school-leaving age. How far this has been successful is shown by the fact that the raising of the age is only now put off on financial grounds, for it would involve maintenance allowances as well as extra cost of teachers and schools. Many educationists, realising the intimate connection between education and industry, and the necessity for the one being a preparation for the other, would prefer to see educational life merge into industrial life by a period of compulsory continuation education, rather than to raise the age of entry to industry. Lord Eustace Percy has recently suggested a rather ingenious scheme the object of which is to realise the benefits of both and the disadvantages of neither. He suggests raising the school-leaving age without allowances but with exemptions, and the exemption would be conditional upon the attendance of the juvenile at a day continuation school up to 16. The scheme provides for a flexible adjustment between school and work. Employers who needed juvenile labour would be able to get it at a certain amount of trouble due to providing for the continuation periods for two years, which they might well regard as the lesser evil. The demand for juvenile labour is not likely to be viewed with sympathy for long, on account of the general unemployment problem and the chance of using the schools to relieve it. We have less sympathy for the raising of the age than for the continuation scheme, and the former is approved rather by the theorists than the practical men. A final suggestion by Lord Eustace, if the five-day working week were adopted generally, is that young persons engaged in industry could be sent to school on Saturday mornings when existing elementary school buildings were not in use for their normal purposes. Altogether, the proposal is worth careful thought, and should have the attention of all engaged in industry lest they find the increase in age legally effective before they have taken action.

Standardising High-Duty Cast Iron

It does not seem very long ago since Mr. John Shaw asked us to edit the proposals of the Cast-Iron Specifications Sub-Committee of the Institute of British Foundrymen for placing before the British Engineering Standards Association. Yet, since that time, such progress has been registered that the time is ripe, not so much for a revision—although actually something could be done in that direction also—as for the preparation of an entirely new specification to include the modern high-duty cast irons. On a tensile basis, these could be usefully divided into three categories, ranging from 33 to 24 tons per sq. in., from 24 to 20 and from 20 to 16 tons per sq. in. Probably, two instead of three diameter bars would suffice for the expression of tensile and transverse, but whilst consideration is being given to the subject an attempt should be made to express within the specifications the strength at elevated temperates, the wear resistance, the modulus of elasticity, and so on.

Already, in the United States, the higher-strength irons have received specificational recognition and international conditions now demand similar considerations from the British end; otherwise, the foreign buyer may be led to the erroneous conclusion that British technique was lagging behind that of American practice. This is far from the truth, and before writing this article we were aware of an important body of opinion that strongly favours the institution of higher specifications. In fact, an approach has already been made to the British Standards Institute.

In making this appeal we are cognisant of the difficulties which may arise through the great national buying authorities demanding these newer products for gargantuan castings, where conditions of melting such large quantities and of holding metal in the liquid condition for prolonged periods have a profound effect on ultimate tests. Yet with reasonable discrimination and proper propaganda on the part of the foundry industry, such demands can be relegated with advantage to existing specifications. The proposed specifications in the main relate to sections of more modest proportions and possibly from this angle could be made to exclude the type of casting which places such heavy demands on the melting facilities normally available within the foundry industry.

C

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Water in Sand

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I am very much interested in Mr. Logan's letter published in last week's issue, respecting the question above and his suggestion for the best means of testing the moisture in sand as received.

This method seems to me to be very cumbersome, and as the amount of moisture in sand is in many instances dependent on the grain size, say, for example, silica sand, ordinary foundry sand, loam. One will be apparently soaking with 4 or 5 per cent. and the other will be comparatively dry with 8 per cent.

Scores of foundries at the present moment are using the "Speedy" moisture tester which enables them to check any sand on arrival, the cost of each test being one-third of a penny and the time required two minutes. The cost of the apparatus is low and, as a matter of fact, bearing out Mr. Logan's remarks, the whole cost was saved on one consignment in one particular instance, the quantity in question being 200 tons.—Yours, etc.,

J. H. COOPER.

47, Coniscliffe Road,
Darlington.
February 18, 1935.

Sandblasting

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I have read with considerable interest the letter from Mr. C. J. Nurcombe, printed in your issue of January 31, and wish to thank him for his courteous preamble.

In my Paper I claimed that "as a general proposition, all other factors being equal, the higher the pressure the greater the cleaning capacity. Twice as much work is accomplished at 50 lbs. pressure than is at 20 lbs. pressure, and at 64 and 72 than is at 30 and 40 lbs. respectively." Owing to a revisionary error, these figures were incorrectly grouped.

I cannot understand Mr. Nurcombe's statement that "the extent of work done depends on the bore rather than the pressure," because, obviously, it depends upon both. Further, the figures I quoted were evolved by actual experiment both in this country and in America, and can be proved by anyone possessing the necessary plant and experience.

It must be noted, also, that my Paper was given to members of The Institute of Vitreous Enamellers, and their particular industry was my major concern on that occasion.

My claim is that a greater production of surfaces suitable for vitreous enamelling results from using a finer grade of metallic abrasive at higher pressures than are used in this country at present. An automatic abrasive separator and cleaner is essential, in order to guarantee full use of such a fine grade of abrasive.

Sandblasting a casting for general cleaning purposes (*i.e.*, the removal of foundry sand, etc.) is an entirely different proposition from preparing a casting or structure for vitreous enamelling, and the two operations must not be confused.

Regarding the sandblast barrel, I am quite conversant with the type of plant Mr. Nurcombe mentions, as giving satisfactory results, but my reasons for dismissing such plant in a few words were based upon my own practical experience and observation, and the fact that such a very small percentage of such plants are used for preparing

(Concluded in next column.)

District Presidents

No. 16

FALKIRK SECTION OF THE INSTITUTE OF BRITISH FOUNDRYMEN

Mr. William Walker, the President of the Falkirk Section of the Institute of British Foundrymen, is a native of Falkirk and served his apprenticeship there as a fitter. Over forty years ago he entered the employment of Messrs. Smith & Wellstood, Limited, ironfounders, Bonnybridge. Some years afterwards he was appointed foreman fitter, and then later, works foreman. Since the Falkirk Section of the Institute of British Foundrymen was inaugurated in 1921, Mr. Walker has been a member, and has always taken an active interest in its activities.

MR. WILLIAM WALKER.

The Leipzig Spring Fair

This year the Fair, which will be held from March 3 to 10, is to be of special interest for the foundry industry, as not only every type of foundry plant is to be shown but in addition every variety of casting is also being exhibited. Still more important from the British point of view is a well-arranged technological exhibit which is to portray cast iron as an engineering material. It will illustrate all the recent advances in foundry technology, including the higher physical properties now available and potential uses envisaging these developments.

(Concluded from previous column.)

anything but the surfaces of very small work for vitreous enamelling.

Finally, I am amazed at the last paragraph of his letter, and suggest that he studies carefully the relative merits—as applied to the vitreous enamelling industry—of both room and rotary table types of plant, and the appurtenances of each, a little more closely, before making such statements. Having satisfied himself from actual experience and observation of such relative merits, and having reached a decision, I shall be glad if he will revert to the matter again, as a subject for discussion.

Yours faithfully,

KENNETH HILL.

Harrison Bros. (England), Limited.
February 19, 1935.

Cast Iron Recovery in America

In a review of American metallurgical developments in 1934 the "Iron Age" states that although for a time cast iron lost prestige in favour of competing materials, there is every indication that this common material is gradually regaining lost ground. This recovery is based to a considerable extent on the turning of founders to electric-furnace melting as rapidly as economic conditions permit the change. Thus the iron melts are more easily regulated and are more dependable, the melting is faster and superior to older methods, the metal is more homogeneous, and better control of alloying elements is assured. In addition a greater variety of metals can be poured each day, thereby assuring each customer the physical properties which are desired at minimum expense to the foundry.

Poor cupola iron is a brittle material with a tensile strength around 13.39 tons per sq. in., whereas close technical control may lift this strength by about 8.93 tons per sq. in. But a ductile electric iron with a strength of 35.72 tons per sq. in. is possible, and with discreet inoculations of alloying elements, such as nickel, chromium, molybdenum, copper, silicon, vanadium, titanium, etc., the strength can be raised to well over 44.65 tons per sq. in. Such a strength can be combined with a great variety of ductilities and abrasion, shock, and corrosion resistances which vary with the admixture of elements.

A number of foundries have seen fit to meet more severe marketing conditions by the use of electric furnaces, and around 30 installations totalling about 4,000 kw. were placed in operation during the past twelve months. A number of these concerns are now turning out low-priced grey-iron castings which are comparable from a physical standpoint with malleable iron and steel castings.

As founders are turning to electric melting to secure improved irons, so are they becoming cognisant of the advantages of electric furnaces to superheat iron melts. With a controlled melting atmosphere the bath temperatures may be held sufficiently high to dissolve thoroughly all graphite carbon before tapping. To show this, test-bars were cast by the Worthington Pump & Machinery Corporation—one tapped at 1,428 deg. C. and the other tapped at 1,649 deg. C. The superheated iron showed a 21.5 per cent. improvement in transverse strength, 42.9 per cent. increase in tensile strength, and advances in hardness and deflection. Although the superheated iron was 7.5 per cent. harder, it was also found to be 6.2 per cent. easier to machine.

Influence of Maximum Heating Temperature on Cast Iron

The study of the influence of maximum heating temperature on grey cast iron has been the subject of many investigations at the American Bureau of Standards, and additional data on this subject have just been released. Four batches of each of three irons were prepared by heating to 1,400, 1,500, 1,600 and 1,700 deg. C., respectively. The strength of a bar of a given diameter was found to depend on the maximum heating temperature. In two types of iron (2.03 and 2.70 C, 0.019 and 0.021 S, 0.15 and 0.23 Mn, 0.65 and 0.86 P) the maximum strength did not occur at the same maximum heating temperature for bars of different diameter. In a third type of iron (1.17 Si, 0.054 S, 0.56 Mn, and 0.10 P) the transverse breaking strength increased progressively up to 1,600 deg. C. for bars of all diameters. In general the running quality of these irons was not materially affected by the maximum heating temperature, but was more of a function of the liquidus temperature. For any two irons poured at the same temperature, the running quality was found to be better in the case of iron having the lower liquidus temperature. The microstructure of the samples showed that high strength is associated with relatively small graphite flakes and a pearlitic-sorbitic matrix.—"Iron Age."

Some Experiments in the Duplication of the Intrinsic Properties of Cold-Blast Pig-Iron

By J. E. HURST

The fact that the properties and behaviour of pig-irons frequently vary in a manner which cannot be predicted from the knowledge of the chemical composition, or even the fractures, is quite well known, and numerous examples of incidents confirming this have been reported by reliable observers over a long period of years. Perhaps the outstanding examples of difference in properties and behaviour for irons of similar composition are to be found in comparison of the properties of cold-blast pig-irons made by other methods. These differences in properties and behaviour are still utilised in the section of the ironfounding industry devoted to the production of cast-iron rolls where pig-irons produced in cold-blast furnaces are still used on account of their desirable properties. The high cost of true cold-blast irons has frequently operated as an incentive to endeavour to produce pig-irons by cheaper methods which would still possess those properties of cold-blast irons, frequently described as intrinsic properties. There are quite a number of recorded attempts to this direction, and as an example it is possible to quote the work of the late J. E. Johnson, jun., in the U.S.A., whose investigations culminated finally in a British patent for a method of duplicating cold-blast pig-iron from hot-blast pig-iron. The method consisted of blowing oxygen gas through molten hot-blast pig-iron and was based principally on the observation that metal so treated yielded a structure under the microscope possessing characteristics similar to cold-blast iron specimens examined.

Nature of Differences

Whilst there are plenty of references in the technical literature of the world to these experiences of differences in behaviour and methods of making hot-blast irons equal to irons produced by cold-blast furnaces, there does not appear to have been any attempt systematically to investigate the nature of these differences. It would appear that such an investigation should precede any attempt to formulate methods of duplicating the properties. For a number of years now the writer has given some attention to this matter in the research laboratories under his control, and as a starting point endeavoured to summarise the differences in properties claimed for cold-blast irons by those who had had considerable experience of their use. Inquiries revealed general agreement that cold-blast irons had differences in the various attributes of their strength properties, and also differences in the chief characteristics obtained when casting either chill test-pieces or actual chilled rolls.

The views on the strength properties may all be summed up fairly in the statement that cold-blast irons are tougher than other irons. The chill characteristics are described by reference to the depth of chill and its hardness; the depth of mottled portion following the chill; the type of chill which is described in terms of brightness and utilises such descriptions as bright, dull, medium bright, normal, etc.; and the type of general fracture following the chill and mottle which is described in terms of closeness, openness and greyness. It is unnecessary almost to state that the comparisons of these chill characteristics are made upon test specimens cast under controlled conditions of size and chill surface, and are considered in relation to the chemical composition of the specimens. Whilst to the experienced eye these chill characteristics are readily distinguishable, none of them, with the exception of the depth and hardness values, is capable of being expressed in numerical quantities, and this, of course, makes investigation somewhat difficult. There are, of course, several ways of overcoming difficulties of this type.

Lack of Data

In a like manner, in the case of toughness, little enough evidence of a quantitative character is available, and this state of affairs is due probably to the fact that the measurements of the "toughness attribute" of the strength properties of cast irons has not been practised in testing laboratories, most workers being generally satisfied with the simple determination of the ultimate breaking strength, which, of course, is not necessarily related to the toughness.

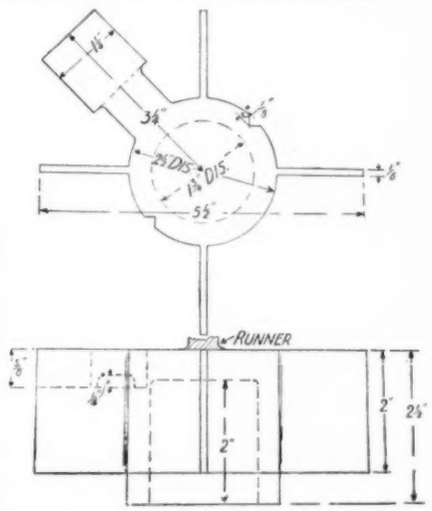

FIG. 1.—DETAILS OF "STAR" (B.C.I.R.A.) TEST-BAR.

Further discussion of these problems with experienced users of cold-blast pig-irons revealed the fact that it is frequently possible to obtain other types of irons possessing some of the properties. For example, it is possible to duplicate the hardness and depth of chill quite frequently by suitable manipulation of the chemical composition, but it appears to have been rarely possible in the past to duplicate all the properties in the same brand of pig-iron.

Good Resilience Values

It was considered that any investigation work undertaken with the object of attempting to

TABLE I.—*Properties of Cold-Blast and Other Irons.*

	Pig-Iron.	Composition.					Chill Test Details.							Mechanical Properties.						
		T.C.	Si.	Mn.	S.	P.	Chill Depth.	Chill Type.	Scler.	Brin.	Firth.	Mottle Depth.	Type Back.	Tens. Tons/sq. in.	Mod. Rupture.	En Value.	Resil.	Limit Property.	Perm. Set.	Type of Curve.
							In.					In.								
1	Valley	3.71	0.52	0.39	0.125	0.37	¾	Bright	63	465	522	1½	Med. open Grey Air chill.	25.4	40.5	17.0	28.2	12.0	6.8	Good
2	Swedish	3.16	1.32	0.28	0.050	0.18	⅛	Dull	58/60	440	488	⅜	Close grey	22.6	36.2	16.8	29.8	13.0	8.8	Good
3	Grazebrook	3.00	0.83	0.42	0.139	0.43	¾	Norm.	60	420	460	1½	Close grey	25.9	41.5	17.1	29.8	13.0	8.8	Good
4	Dudleys	3.49	0.83	0.59	0.105	0.48	—	Med. Bright	60	433	481	¾	Med. open Grey	16.8	26.7	17.5	20.6	—	9.5	Poor
5	Charcoal	3.99	0.91	0.41	0.106	0.16	Trace	Bright	—	221	237	Nil	Very open Grey	20.2	32.2	16.9	21.6	—	15.6	Mod.
6	Ordinary refined No. 8070.	3.11	0.75	0.30	0.071	0.39	⅛	Norm.	58/60	400	428	1	Close grey	18.6	29.8	16.6	15.5	—	2.5	Poor
7	Refined iron substitute, 7B/9.	3.43	0.87	0.54	0.096	0.42	1/16	Dull	60/65	465	526	⅞	Med. grey	19.6	31.4	17.9	20.8	12.0	5.4	Good
8	Blended all-mine, re-6B/2.	3.71	1.12	0.41	0.068	0.49	⅛	Bright	55/60	480	551	Nil	Open grey	26.8	43.0	17.8	30.8	14.0	7.5	Good
9	Blended all-mine, refined 8411.	3.82	0.66	0.45	0.08	0.44	¼	Very Bright	70	495	575	⅜	Open grey	25.9	41.5	18.0	29.75	14.0	12.4	Good
10	No. 5 charcoal, with 60 per cent. roll scrap	3.00	0.66	0.25	0.110	0.35	1	Med. Bright	60	440	488	1 1/16	Close grey Air chill	25.9	41.5	17.2	25.4	—	14.8	Mod.
11	No. 7 refined iron substitute 7B/9, with 33 per cent. roll scrap	3.11	0.69	0.47	0.128	0.37	1	Dull	50/55	440	479	2	Med. grey Air chill	20.1	32.2	18.0	19.5	12.0	6.6	Good
12	Blended all-mine, 6B/2 50 per cent. roll scrap	3.27	0.79	0.35	0.126	0.45	1	Dull	60/62	470	510	2⅛	Close grey Air chill	25.8	41.3	18.1	31.5	14.0	7.8	Good

duplicate the properties of cold-blast irons should be concerned in the first place with determining the quantitative value of the differences in the various attributes of the strength properties. With this end in view, a large number of specimens have been examined for modulus of elasticity, resilience value, limit of proportionality, permanent set, internal stress, elastic hysteresis, in addition to the ultimate breaking strength or modulus of rupture. These tests confirmed the observation that cold-blast irons showed differences in properties and a series of these are included in the first set of six results shown in Table I. Here the properties of a series of specimens taken from reputable brands of cold-blast irons are compared with those of an ordinary refined iron. Special attention is directed to the marked difference in the resilience value in addition to the differences in ultimate breaking strength.

These investigations were followed up by the examination of the same properties in a variety

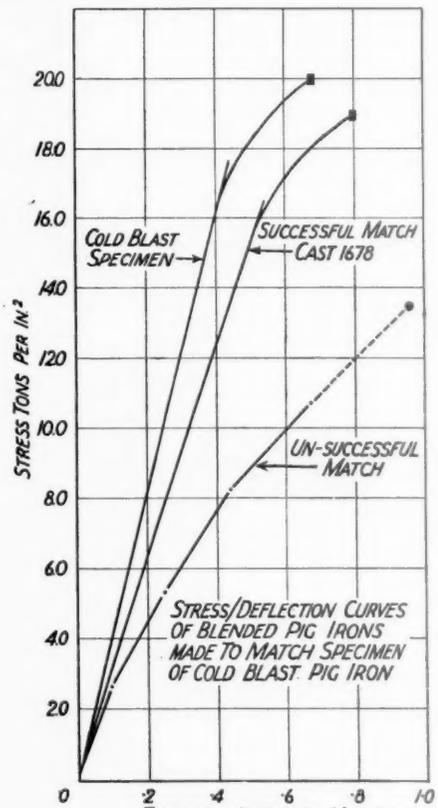

FIG. 2.—STRESS/DEFLECTION CURVES OF BLENDED PIG-IRONS MADE TO MATCH COLD-BLAST PIG-IRON.

of pig-irons prepared by the various methods in common use and derived from different districts and countries. A large number of these results have been published already by the author in a Paper, reference to which will show widely-differing properties.* Eventually it was decided that this might form the basis of additional scientific blending methods with the object of duplicating exactly the properties of a given type of pig-iron. Following this decision, the chemical analyses of pig-iron supplies have been reinforced by the complete mechanical analysis in which the properties as above mentioned are determined. In order to match the specific properties of a given type of cold-blast pig-iron the procedure followed is first to determine the chemical analysis and the complete mechanical properties of the particular brand or consignment of iron required to be matched. With this information available, a mixture is devised from the various materials in stock of which the chemical analyses and mechanical properties have been determined. The mixture is calculated to give a mean chemical and mechanical analysis closely approximating that of the sample desired to duplicate. The success of this procedure relies on the assumption that the differences in properties of the mixed materials survive remelting, and this assumption has been submitted to experimental verification. The test results Nos. 7, 8 and 9, in Table I, refer to three attempts to match the properties of the charcoal specimen No. 5. The results show that this has been done successfully, and it will be noted that the results, in so far as chill characteristics, are closely in accord with the original sample. The experiment was carried further to the extent of comparing the properties of the blended irons Nos. 7 and 8 with that of the charcoal iron No. 5 when remelted in admixture with roll scrap following the procedure adopted in the roll foundry. Here again it will be seen that the results obtained show that the blended sample No. 8 has provided a very satisfactory match to the natural sample No. 5. This experimental work demonstrates clearly that the intrinsic properties of cold-blast irons can be matched both in mechanical properties and chill characteristics by this method. The actual details of the methods adopted in matching the exact properties of different pig-irons can be followed from the description of the experimental procedure followed in matching a well-known brand of cold-blast iron from a sample submitted. The sample received was in the form of a half pig and the chemical analysis taken on drillings from the face of the pig in the manner recommended in the B.C.I.R.A. sampling methods gave the following results:—

	Original iron.	As remelted for test specimen.
	Per cent.	Per cent.
Total carbon	3.55	3.40
Silicon	1.83	1.82
Manganese	0.87	0.74
Sulphur	0.050	—
Phosphorus	0.48	0.47
Nickel	Nil	—
Chromium	0.050	—

Experimental Data

The supplier confirmed that the rather unusual silicon and manganese contents revealed by this analysis were representative of the normal quality of this iron as purchased by them. For the determination of the various attributes of the strength properties a portion of the specimen was remelted in a Morgan oil-fired crucible furnace using a clean new standard Morgan Salamander crucible. The metal was heated to a temperature of 1,495 deg. C., as recorded by means of a Foster optical pyrometer, and test-pieces were cast from this temperature into the form of the standard "Star" test-bar moulded in oil-sand moulds standing at a temperature of 85 deg. C. measured by a mercury thermometer inserted down the ingate of the mould. The details of the standard "Star" test-bar are shown in Fig. 1. The fins of the "Star" bar when broken showed very slight chill, not more than $\frac{1}{8}$ in. at the extreme edges and standard test-rings were machined from the cylindrical barrel of the test-bar. These rings were used for the determination of the following properties:—(1) Internal stress value; (2) modulus of elasticity (En value); (3) modulus of rupture (tensile strength); (4) stress/deflection curves; (5) resilience value; (6) permanent set value; (7) elastic hysteresis curve, and (8) Brinell hardness (Firth Hardometer 2-mm. ball, 30-kg. load).

Results Obtained

The ring tests and stress calculations were made in accordance with the methods laid down in B.S.I. specification No. 5004. Chemical analyses were made of the remelted specimens with the object of ascertaining the magnitude of any changes which may have taken place in remelting. The results are given for comparison alongside those of the original specimen, and the only change of any magnitude to be noted is the reduction in total carbon and manganese contents. The mechanical-test results obtained are summarised in Table II. In the case of some

TABLE II.—*Properties of Cold Blast and Synthetic Irons.*

	1. Cold-blast specimen submitted for matching.	2. Blended iron first attempt.	3. Blended iron cast 1648 successful.
Tensile strength, tons per sq. in. (ring test) ..	20.6	16.5	21.2
Resilience value ..	20.6	14.4	19.8
Permanent set value	12.5	30.6	10.9
Internal stress value	+ 0.003	+ 0.004	+ 0.005
Modulus of elasticity (En value) ..	18.7	13.5	17.9
Brinell hardness ..	215	207	207

of the determinations three separate tests were made, in which case the average of the three determinations has been recorded in the Table. The stress-deflection curve and the elastic-hysteresis curve are illustrated in Figs. 2 and 3, curve No. 1. In general, the results obtained are typical of good cold-blast irons. The resilience value is somewhat lower than the results obtained from previous examinations of this same

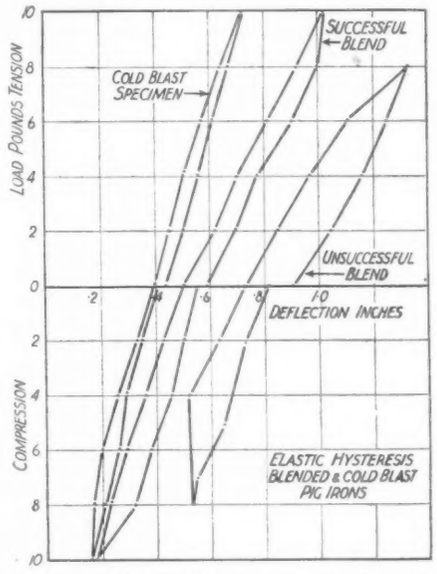

FIG. 3.—ELASTIC HYSTERESIS OF BLENDED AND COLD-BLAST PIG-IRONS.

brand of iron, and this may be due possibly to the fact that the silicon and manganese contents are higher in this than in previous specimens examined. The fracture of this specimen prior to remelting was described as a fairly close No. 3.

With these test results available, a mixture was calculated utilising pig-irons of known mechanical properties in addition to the chemical compositions. The mechanical properties of the pig-irons used were determined on rings machined from "Star" bars cast from remelted specimens of the irons, following the method exactly as above outlined. The mixture as calculated was remelted and cast into pig form, and a specimen of pig taken for the determination of the properties. Here again the same procedure of remelting and casting a "Star" test-bar was followed. The test results of two mixtures calculated to duplicate the properties

(*Concluded on page* 141.)

* Manchester Association of Engineers.

Further Notes on Defects in Steel Castings*

By C. HOWELL KAIN

The literature of steel-casting production is gradually growing, and the metallurgy of both the melting and after-treatment processes is well known. The physical and mechanical properties obtained are excellent, and compare favourably with worked steels; indeed, for some uses, such as heat resistance, there are indications that cast steels yield better results than forged steels. For special purposes and properties a wide range of alloy steels is now available to the founder, and these enable almost any test for service requirements to be met.

Unfortunately, the technique of casting production is not so definitely settled, and for this reason many of the modern publications appear to deal solely with the general inferiority of steel castings. The majority enlarge upon defects in steel castings and a few deal with methods of overcoming them. This is not the place to criticise these various publications and Papers, but it may safely be said that the nature and occurrence of steel castings defects are now widely known, and that future writers and investigators will be rendering most service to the industry if they devote themselves to discussing methods of overcoming these defects. A series of Papers, each containing a study of one type of defect only, would be of the utmost value.

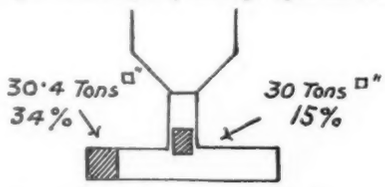

FIG. 1.—WEAKNESS DUE TO FREEZING AND COOLING PHENOMENA.

Principal Defects

The three chief defects troubling the steel-founder are firstly cracks, secondly draws, thirdly gas holes. The term "gas holes" is here used to indicate cavities caused by gases arising directly or indirectly from the mould or mould materials. Many of these may truly be termed blowholes, and are caused by such things as excessively-damp moulds, wet external and internal chills and impermeable sands. Others arise from trapped gas caused by excessive pouring speeds, incorrect gating and uneven flow of metal in the mould. The type of gas hole commonly called "sponginess" or "porosity" has been widely discussed and written upon, but has not been considered here because the remedy lies in the working of the furnace and melting procedure. The cavities are similar to those which are deliberately made in running steel for certain types of ingot, and if this is borne in mind they are easily prevented. There are numerous other possible defects, of course, but these three are the most important, and also the ones over which the moulder has the greatest control.

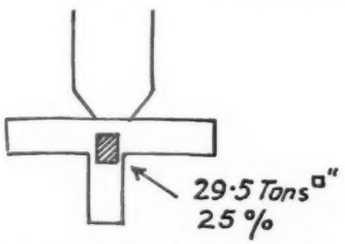

FIG. 2.—SHOWING HOW FEEDING CAN IMPROVE MECHANICAL PROPERTIES (JEFFERSON).

* A Paper read before the Sheffield and East Midland Branches of the Institute of British Foundrymen.

Cracks

Dealing first with cracks, it was stated in a Paper* that all cracks could be put under four broad headings:—(1) Cracks caused by carelessness and lack of provision to allow for obvious contractions; (2) cracks caused by inadequate feeding, usually at a change of section or a re-entrant angle; (3) plain contraction cracks resulting from the casting behaving differently from expectation, and (4) cracks caused by weakness of metal section.

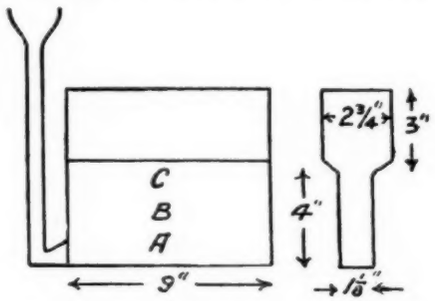

FIG. 3.—TEST-BLOCK USED FOR OBTAINING FIGURES DETAILED IN TABLE I.

Of these, the first and third call for little comment, as the causes are well understood and the methods of prevention within the power of every workman.

The second cause is not so easily disposed of, as this crack is closely related to plain shrinkage or draw, and also in many cases to blows or gasholes. Fortunately, it is easily overcome by the provision of a feeder or, better still, designing the casting so as to cause progressive freezing away from the seat of trouble. Quite probably this suggestion contains the whole cause of this type of defect, in that a study of the cooling rates of the various adjacent portions of the casting will show that progressive freezing *does* take place, but towards the possible seat of trouble. In many cases this effect is accentuated by the enclosure of a small portion or section of sand, causing a local heat reservoir and hot spot. In addition to the localisation of the shrinkage in this place due to heat conservation, it is often easier for mould gases from the small peninsula of sand to blow their way into the hot pasty metal than to force their way backwards through the body of the mould. As the metal is partially solidified and the primary dendrites formed, the cavity takes the form of a narrow, jagged hole in the corner of the casting, and is frequently mistaken for a tear or a draw. The absence of the characteristic smooth appearance of the usual blowhole is deceptive. If the design of the casting and the position of the defect is such as to allow the placing of a feed head above the defect, the trouble frequently disappears, though it is difficult to say without a study of each individual case whether this is due to feeding the pipe which tends to form or to allowing the gas ready escape through a larger bulk of liquid metal.

FIG. 4.—ILLUSTRATING POSSIBLE REASON FOR TEST-BAR STRENGTH VARIATIONS.

The fourth main cause of cracks, weakness of metal section, shown in Fig. 1, does not refer to weakness of design, but to inherent weakness in the metal section, resulting from the phenomena of freezing and cooling. Mention of this was made by Mr. Jefferson at the Symposium* on Steel Castings held in Glasgow. To illustrate the point, Fig. 2 shows how adequate feeding improves the properties of the material, being the same casting reversed, and with a test-bar cut from the same place. These results are, of course, on the annealed casting. In both cases the casting appears solid and sound to all ordinary methods of examination.

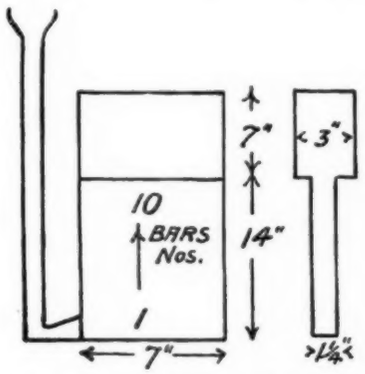

FIG. 5.—TEST-BLOCK FROM WHICH THE FIGURES SET OUT IN TABLE II WERE OBTAINED.

TABLE I.—*Strength at Places Indicated in Fig. 3.*

Position.	Y.P. Tons per sq. in.	M.S. Tons per sq. in.	Elong. per cent.
A	20.48	31.86	34
B	21.06	31.48	24
C	20.28	31.48	28
A	20.28	33.64	31
B	19.72	33.52	22
C	19.40	33.04	26

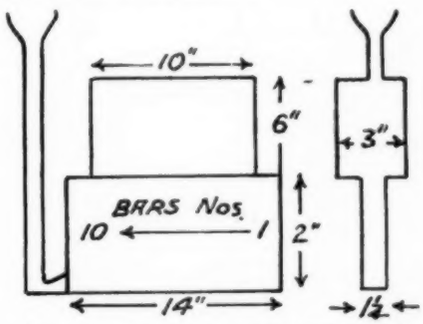

FIG. 6.—TEST-BLOCK FROM WHICH THE FIGURES DETAILED IN TABLE III WERE OBTAINED.

In 1927, the author showed that, even in the ordinary block cast for test-bar purposes, there are remarkable and striking differences between adjacent bars. Fig. 3 shows the test block referred to, with dimensions and method of running, and Table I the results quoted.

* FOUNDRY TRADE JOURNAL, Vol. XLVIII. pp. 95 and 108.

* FOUNDRY TRADE JOURNAL, Vol. XXXIX, p. 393.

In Fig. 4 is shown a diagram which was an attempt to explain the cause of the difference in strength of the various bars cut from the same block. It was suggested that as the metal cools it freezes in a continually-thickening envelope on all sides. The first crystals or dendrites formed conduct the heat away from the liquid in the centre, which then solidifies and carries the process a little further. A point is quickly reached when there is a very thin column of liquid metal in the centre, and the heat is conducted away from this so rapidly

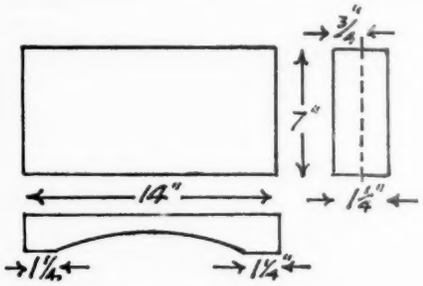

FIG. 7.—MODIFIED TEST-BLOCK, THE RESULTS FROM WHICH ARE DETAILED IN TABLES IV AND V.

that crystallisation starts almost simultaneously down the full depth of the block from centres independent of the original dendritic walls. As these last crystals form and cool, they contract and rely on liquid falling by gravity from the head to feed the minute spaces left, but the pressure and fluidity of the metal in the head is only sufficient to force its way a short distance down. It will be seen then that since bar A freezes from all three sides, it consists entirely of primary crystals, while the centres of bars B and C consist of secondary crystals. The feed metal from the head has fed bar C efficiently, but it appears that bar B is inadequately fed in the centre.

TABLE II.—*Blocks Cast on End as Shown in Fig. 5.*

No.	M.S. Tons per sq. in.	Elong. per cent.
G. 1–1	30.4	26
G. 1–3	26.04	11
G. 1–5	26.16	12
G. 1–7	24.84	9*
G. 1–9	27.12	16
D. 2–1	30.12	27
D. 2–3	26.72	9*
D. 2–5	26.12	10
D. 2–7	26.6	14
D. 2–9	27.28	14

* Drawn.

TABLE III.—*Blocks Cast on Side, as Shown in Fig. 6.*

No.	M.S. Tons per sq. in.	Elong. per cent.
G. 3–1	29.28	24
G. 3–3	22.68	7*
G. 3–5	26.88	10
G. 3–7	25.92	11
G. 3–9	28.92	16
D. 4–1	29.04	27
D. 4–3	22.76	12
D. 4–5	24.16	10
D. 4–7	25.24	10
D. 4–9	27.88	21

* Drawn.

In order further to investigate this question it was decided to cast a number of test-blocks of exaggerated size and to take bars for examination. This test-block was 14 in. by 7 in. by 1¼ in., the thickness being that required when a specification called a 1-in. square-bend piece. This bar was cast in various positions and in both green- and dry-sand moulds. Four of the results are given as being representative. Figs. 5 and 6 show the position and size of feeder heads used. Ten bars were cut from each casting and tested in the as-cast condition. Tables II and III show the results obtained.

Owing to an error during machining of the test-bars, only the odd numbers are available. But these show clearly that the metal in the middle portions of the block has much less strength and ductility than the ends, which either freeze from three sides or, in the case of a top bar, are adequately fed from a header.

In order further to investigate the question it was decided to modify the shape of the test block to ensure further penetration of the primary crystals in the middle portions of the block. This is shown in Fig. 7. Sufficient material was left at the two ends of the block to cut bars as before, because in every case previously the two end-bars had shown the maximum properties. Two blocks were cast, one on end and one on its side, each with the same size

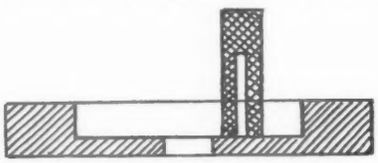

FIG. 8.—SMALL FLYWHEEL TYPE OF CASTING.

of header as was previously used on the parallel blocks. Tables IV and V show the results.

It will be seen that, although theoretically the bars cut from the thick portion of the block away from the feeder should yield inferior results, they have, in fact, given results comparable with those obtained in parallel bars. The bars in the centre are much tougher than the similar bars cut from a parallel block. These results are, of course, from the completely-cooled casting, but it is reasonable to assume that the strengths and ductilities of the various portions of the casting will bear the same relation to one another when hot and immediately after freezing, as they do in the cold state. This fact may account for many cracks or tears which occur in parallel sections of a casting, and it is suggested that in castings of such thickness that it is not possible to ensure (i) all the section being formed or primary crystals, or (ii) adequate feeding of

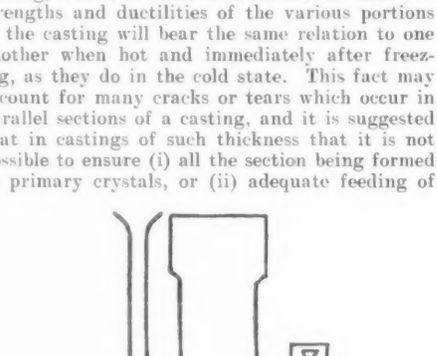

FIG. 10.—SHOWING HOW GAS BUBBLES MAY BE ENTRAPPED.

the shrinkage of the secondary crystals in the centre, greater safety and increased strength in the casting will be obtained by modifying the section on the lines indicated.

The principles underlying the prevention of draws or shrinks are perhaps better known than those governing other defects in steel castings. At the time of writing (September, 1934) a series of Papers are projected for the International Foundry Conference in America, many of which deal with this subject. Various of the technical journals have published excellent articles on the matter, and last year the first part of a comprehensive survey was published in America and in THE FOUNDRY TRADE JOURNAL ("Studies on Solidification and Contraction and Their Relation to the Formation of Hot Tears in Steel Castings," by Briggs and Gezelius).

Pencil Gates

The phrase "progressive solidification" sums up the whole matter. By this the author understands so arranging the design, gating and feeding of the casting that freezing takes place progressively towards the feed heads provided. This is the principle discussed when dealing with the weakness of metal sections, and shows that cracks and draws are very closely allied. In another place a number of applications of this principle have been described, and it is not proposed to repeat them here. Mention may be made, however, of the use of pencil gates. Very frequently the use of a number of small gates in the upper portion of a casting gives excellent results with

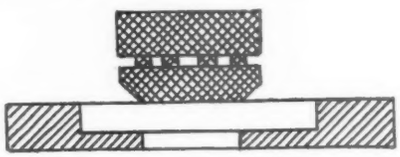

FIG. 9.—APPLICATION OF PENCIL GATING TO THE CASTING SHOWN IN FIG. 8.

very small headers. An example was given last year where the head was reduced from 50 lbs. to 24 lbs. by the use of ⅜-in. dia. pencil gates. The use of pencil gates on steel castings must not be confused with those sometimes used for grey iron. The writer freely admits that he does not fully understand the mechanism of the action of pencil gates, but it may be broadly stated that, with grey iron, the object is entirely to eliminate headers, while with steel the object is to reduce them to a minimum by progressive solidification. This may best be illustrated by an example, Fig. 8, which illustrates a not uncommon type of small flywheel casting. In grey

TABLE IV.—*Block Cast on Side, as Shown in Fig. 7.*

Test No.	M.S. Tons per sq. in.	Elong. per cent.
1	33.92	17
2	29.9	10
3	32.6	12
4	32.9	13
5	31.1	10
6	32.6	11
7	33.0	12
8	32.5	11
9	25.7	4*
10	33.4	15

* Flawed.

TABLE V.—*Block Cast on End (Fig. 7).*

No.	M.S. Tons per sq. in.	Elong. per cent.	Remarks.
10	31.68	17	—
9	31.52	12	—
8	31.52	12	—
7	31.68	11	—
6	30.48	9	—
5	29.20	6	Drawn.
4	26.32	5	Badly drawn.
3	24.44	4	,, ,,
2	22.16	4	,, ,,
1	34.34	21	— —

iron this may be made perfectly solid, without headers, by the use of pencil gates on the lower thin portion of the casting, provided that the iron is of suitable composition. Fig. 9 shows how it would be necessary to use pencil gates if the casting were in steel. It must be made clear that pencil gates are not recommended for this particular casting in steel, because, although it would be possible to make the casting sound with a very small header, it would probably have a very bad surface, due to scabbing and local

fusions of sand. But the design shows an excellent example of the essential difference between pencil gates for grey iron and those for steel.

It is often stated that the ingot is the simplest form of steel casting. This is not so, because the ingot is approximately parallel, and it is often difficult to ensure progressive solidification, hence the use of such aids as heavy chill bases, tapered moulds and sand or firebrick heads. The simplest form of steel casting is the wedge, with the sharp end down. In this case there is definite progressive freezing towards the open end, where it is a simple matter to provide an adequate head. If this illustration is borne in mind it becomes easier to visualise helpful modifications of design and correct gating and feeding.

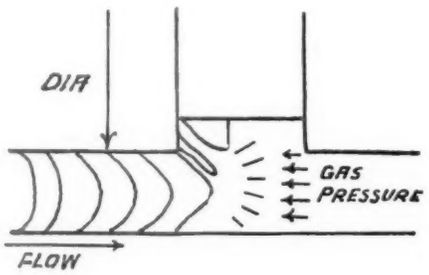

FIG. 11.—PHENOMENON OF INFLUENCE OF BACK PRESSURE ON SOUNDNESS.

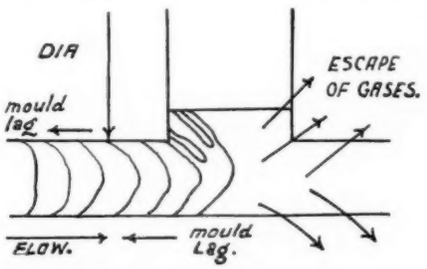

FIG. 12.—DIAGRAMMATIC EXPLANATION OF A CAUSE OF AIR-TRAP DEFECT.

Blowholes

Much has been said and written at various times on the subject of blowholes, and all authorities are agreed that, apart from porous or spongy places due to wild and insufficiently-deoxidised steel, nearly all blowholes are caused either directly or indirectly by the mould materials. These include the sand or compo of the mould, and cores and such extras as facing and dressing materials, horseshoe nails, chills both external and internal, and runner bushes. Personal experience of "compo" moulds is somewhat limited, so the following remarks apply particularly to sand moulds, though they might apply to "compo" also.

Blowholes caused by the condensation of moisture upon chills and nails call for no comment. There is no excuse for their occurrence, although it is often not realised how quickly beads of water condense upon nails and chills after a mould is closed. Sometimes blowholes are caused from the formation of iron oxide on the surface of nails and chills during the drying of a dry-sand mould, which reacts with the carbon in the steel to form CO and CO_2. Here again, the trouble is so obvious that there is no excuse for not ensuring that the film of oxide is removed before casting.

It has been suggested that many blowholes are caused by the entrapping of air or gas due to the high pouring velocities common in the steel foundry. The writer has shown that, owing to the high velocity of the steel entering the mould, it is possible for the steel to flow to the furthest extremities of the mould and climb the sides of the mould, so entrapping a bubble of gas as shown in Fig. 10. This phenomenon appears to be independent of pouring temperature, having been observed with both hot and cool metal. The theory was evolved before sand-testing became common in this country, and in the light of results now obtainable appears to require modification. One would expect that when using a very highly permeable sand escape of mould gases would be so easy as to ensure all gases passing away through the mould before the incoming rush of metal. In spite of this, the defect has been observed when using a sand with a permeability of 300 to 350 (obtained on Richardson's apparatus). Experiments were then made with a sand of much lower permeability, 160 and under (which appears to be the lowest practical limit as scabbing of the mould begins to appear). The defect was still encountered on certain types of casting, the greatest freedom being obtained with a sand of about 200 to 300 permeability. In all these experiments the nature of the sand was the same, being Yorkshire sand of a strong grade mixed with clean silica sand of varying degrees of fineness, and being maintained at a moisture content of 2.5 to 3.5 per cent. with a strength of 6 to 8 lbs. per sq. in.

Another phenomenon which was observed when using the open sand was the presence of cold-laps on the surface of the casting, particularly on inner surfaces on or near to a heavy section on a thin section, as shown in Fig. 11. This suggests that possibly the rapid expansion of the large volume of air enclosed in the sand mould caused back pressure on the surface of the incoming metal which formed a crust through which fresh metal forces its way in the centre, as shown in Fig. 12. Another suggestion is that the very open nature of the sand allows such rapid escape of the gases as to cause a partial vacuum in the mould, and the hotter metal in the centre of the incoming stream rushes through to fill the gap, overlapping the cooler metal nearer the mould surface. Or, again, that the large volume of air conducts heat away from the metal surface more rapidly than the close sand of a dense mould, and so forms laps or roaks, as shown in Fig. 13. All these ideas may be made to fit in with the suggestion that the rapidly-flowing metal travels to the extremities of the mould and encloses a space. In the case of a dense mould there is no doubt that expansion of the mould gases causes internal pressure in the mould, and that the metal, travelling in this volume of high pressure, flows round the outside and encloses a bubble of gas. It is noteworthy that in the low-permeability moulds no cold-lapping was observed. This also may agree with the high-pressure theory of the open sand, in that with the open sand the metal may force the high-pressure gas backwards through the mould and so allow lapping, whilst with the dense sand the resistance of the mould is too high to allow spurts of metal to force their way through the general surface of the liquid.

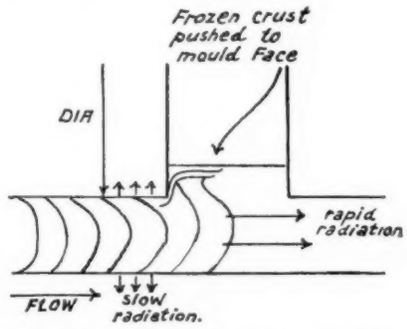

FIG. 13.—SHOWING FORMATION OF LAPS THROUGH RADIATION.

Perhaps these ideas are too fantastic to be true, but it is hoped that they may at least form the basis of constructive discussion.

Some Experiments in the Duplication of the Intrinsic Properties of Cold-Blast Pig-Iron

(*Concluded from page* 138.)

of the specimen submitted are included. The first attempt did not provide a satisfactory duplication, and these results are included as further evidence, to show that, although the chemical composition was matched quite closely, the mechanical properties may differ quite substantially. The second attempt from a modified mixture, Cast 1648, gave a very satisfactory duplication of the properties of the specimen submitted, as will be seen from an inspection of the test results in column 2, Table II, and the stress-deflection curves and elastic-hysteresis curves No. 2.

The chemical analysis of the successful match taken from drillings from the pig and from the remelted test-bar is given below. In this case the test-bar was cast from a temperature of 1,480 deg. C. into an oil-sand mould standing at 81 deg. C. The fracture of this pig-iron was described as a scattered No. 4.

Chemical Analysis of Specimens Cast 1648 *Exactly Duplicating the Cold-Blast Pig-Iron (Table II, Column* 2).

	Pig-iron.	Remelted specimen.
	Per cent.	Per cent.
Total carbon	3.70	3.42
Silicon	1.95	1.90
Manganese	0.95	0.88
Sulphur	0.029	—
Phosphorus	0.51	0.50
Nickel	Nil	—
Chromium	0.026	—

The results in column 3 of the table and the stress-deflection and elastic-hysteresis curves No. 3 show quite substantial differences from the required values, even although the chemical compositions of the specimens are quite close to those required, as will be seen from the following results:—

Chemical Analysis of Specimens. Column 3, *Table II.*

	Pig-iron.	Remelted specimen.
	Per cent.	Per cent.
Total carbon	3.62	3.49
Silicon	1.96	1.92
Manganese	0.90	0.79
Sulphur	0.042	—
Phosphorus	0.50	0.49
Nickel	Nil	—
Chromium	0.031	—

Summary

Differences between the characteristics and properties of cold-blast pig-irons and other types of pig-iron have been observed and experimentally investigated. It has been shown that the chemical composition, fracture and mechanical properties of cold-blast pig-irons can be very closely duplicated in all their characteristics by synthetic mixtures, and that irons which so duplicate these properties in entirety also duplicate the properties of chilling characteristics. Thus, it has been shown experimentally that the whole of the known characteristics of cold-blast irons can be completely duplicated. In this connection it is of special importance to bear in mind that in the preparation of such duplicate blended mixtures, the desired properties of the cold-blast irons can be adhered to and can be the subject of close control. For this reason such blended irons may possess a much greater degree of uniformity of properties and characteristics than cold-blast irons, and the variations which occur in such cold-blast irons over a period can be avoided. It is necessary to add that these investigations were carried out in the research laboratories of Messrs. Bradley & Foster, Limited, Darlaston, to whom thanks must be accorded for their permission to publish the results.

Foundry Coke

ITS MANUFACTURE AND PROPERTIES

The members of the Lancashire Branch of the Institute of British Foundrymen recently paid a visit to the Lancashire Foundry Coke Company's plant at Altham, Accrington. The meeting was held jointly with the members of the West Riding of Yorkshire Branch. The members of the two Branches were welcomed by Mr. G. C. M. Barlow, chairman of the Lancashire Foundry Coke Company, Limited, Mr. D. V. Hollingworth, manager, and Mr. Norman Eltoft, chief salesman.

Historical

The coke ovens and by-products works of the Lancashire Foundry Coke Company, Limited, are situated near the Burnley to Blackburn main road at a point where it crosses the Leeds to Liverpool canal, and on a site which has for some time been connected with the winning of coal from the well-known seams of the Mountain Mine, and with its carbonisation into high-class coke.

As long ago as the year 1885, there were patent ovens in operation at Altham, and many years before then Beehive coke was being manufactured on a large scale in the district.

Towards the middle of 1927 it became evident that ovens which had done duty for more than forty years were ill-suited to the requirements of the times, and the Altham Colliery Company (1924), Limited, decided to erect a battery of modern ovens. A contract for the construction of 18 "Still" ovens was accordingly given to Messrs. Coke & Gas Ovens, Limited, and the ovens successfully started up in October, 1928. About that time the Altham Colliery Company (1924), Limited, Messrs. George Hargreaves & Company, Limited, and the Exors. of John Hargreaves, Limited, amalgamated their coking interests by the formation of the Lancashire Foundry Coke Company, Limited, and it was decided to discontinue carbonisation in Beehive ovens. Additional ovens, therefore, became necessary, and the erection of two more batteries of 18 ovens each was entrusted to Messrs. Coke & Gas Ovens, Limited, who duly completed their contract and brought the ovens into operation in April, 1930.

Owing to the coke business being taken over by the Lancashire Foundry Coke Company, Limited, and its obligations to supply gas to the townships of Accrington and Burnley, the requirements of the company were comprehensive and exacting.

Plant Details

It was a definite instruction to Messrs. Coke & Gas Ovens, Limited, that there should be provided a plant complete in all respects, designed for the manufacture of high-class foundry coke, blast-furnace coke and graded coke, and that coal gas should be produced of a quality, after purification, suitable in every way for all town purposes.

It was also stipulated that the ovens should be so designed as to enable them to be heated by coke-oven gas or producer gas at will, so that in the event of an expansion of the sales of gas the whole of the coal gas made could be thus disposed of.

The plant designed and erected by Messrs. Coke & Gas Ovens, Limited, to meet these requirements, consists of:—

Fifty-four compound regenerative "Still"-type coke ovens built of high-grade silica material, and having a guaranteed throughput capacity of 4,500 tons of air-dry coal per week, together with all the necessary operating machinery, storage bunkers, by-product recovery and benzol-rectification plant, etc.

The site upon which the ovens were built consists of heavy clay conglomerate, and was considered ideal for the purpose. So heavy was the burden to be placed upon it, however, that a raft of reinforced concrete no less than 2 ft. thick was laid down.

Storage for slack is provided by two reinforced-concrete bunkers, having a total actual capacity of 1,600 tons. The older bunker, erected at the same time as the first battery, has two compartments, each holding 320 tons, whilst the new one has three compartments of similar size.

All have sliding doors at the bottom, operated from the platforms of the larry cars by hand-wheel, rack and pinion.

The oven chambers and sole flues are constructed of high-grade silica material having an underload softening point of 1,690 deg. C., the regenerators and oven tops being constructed of semi-silica material.

Each oven has a capacity of 13.5 tons of slack and a carbonising time, when on full output, of 22 hours.

The guaranteed throughput capacity was 4,500 tons of air-dry coal per week, but the actual capacity has proved to be considerably more.

After their inspection of the plant, the members of the Branches were subsequently entertained to tea by the kind invitation of the chairman and directors of the company.

Modern Requirements

MR. GEORGE C. M. BARLOW, in extending an official welcome to the members of the Branches, said he realised that he was in the presence of gentlemen whose goodwill was certainly necessary if he and his colleagues were to have any peace of mind. It was, therefore, a very great pleasure indeed for him to be able to meet the members of the Branches upon that occasion. It was merely necessary to mention that there had been a great deal of enterprise and adventure in connection with their installation. One point to be mentioned was that, although the company collected the surplus gases produced during the operation of the plant, yet they could not always bring people to understand that the manner in which those surplus gases were collected had nothing at all to do with the quality of the main product, which was foundry coke. The ovens had been built for the sake of making foundry coke of high-grade quality, and not for the purpose of manufacturing gas. At the same time, they did not desire that the gas which was evolved during the operation of the plant should pass away freely into the atmosphere. Thirty or 40 years ago there was as much gas allowed to escape into the atmosphere within a mile or two of the present works at Altham, though, of course, never at Altham itself, as would have satisfied the domestic requirements of Accrington, and probably the whole of Burnley. He wished to dispel the idea, if it prevailed, that the making of gas was the main objective at Altham and not the making of foundry coke.

Vote of Thanks

MR. W. N. COOK (President of the Lancashire Branch) proposed that a hearty vote of thanks be accorded to the chairman and directors of the Lancashire Foundry Coke Company, Limited, for their invitation to visit the works and for their subsequent hospitality to the members of the Branches, and also to Mr. Hollingworth and Mr. Eltoft, who had so unselfishly devoted their Saturday afternoon's leisure time to showing them round the plant and explaining its operations. It was a great privilege to be permitted to visit a plant of such a modern type.

MR. J. JACKSON (Accrington) seconded the vote of thanks. Although what was usually termed patent-oven coke had been on the market for a very long time now, nevertheless the old form of beehive coke had not entirely been forgotten by many of those present. It was obvious from what they had seen of the operations of the company's plant that great strides had been made in the manufacture of foundry coke, and that a line of development was being pursued which would be all to the benefit of the foundry industry generally. The company were not merely producing a high-grade foundry coke, but, what was also of great importance, they were maintaining a clean, pure atmosphere in the neighbourhood of their plant, in addition to producing dyestuffs and perfumes.

The vote of thanks was carried unanimously by acclamation.

A Paper, of which the following is an abstract, descriptive of the process carried out at the plant of the Lancashire Coke Foundry Company, Limited, was then read by Mr. D. V. Hollingworth.

The Manufacture of Coke*

By D. V. Hollingworth, F.I.C., M.Inst.Chem.E.

When coal is carbonised in an oven, it would appear that the following series of reactions occurs:—(1) At above 100 deg. C. free water and occluded gases are driven off; (2) between 100 and 200 deg. C. combined water and some gases are evolved; (3) between 370 and 500 deg. C. a part of the coal softens and much volatile matter comes off; (4) the plastic mass swells and the evolution of volatile substances reaches its maximum—the mass becomes cellular; and (5) at between 700 and 800 deg. C. the residue shrinks, becomes a solid cellular mass, and cracks appear. It is quite clear that these happenings occur in vertical layers parallel to the oven walls. The layer nearest the oven walls becomes plastic and finally coked, long before the centre of the charge has become quite dry; consequently the gases given off during the later stages of carbonisation and formed in the centre of the charge have to pass through the layers of coke already formed. (6) Those gases first formed are decomposed, and amorphous carbon is deposited on the coke. So that coke consists of two parts, the skeleton and deposited C. (7) The process is complete when the temperature of every part of the charge has reached about 1,000 deg. C.

The nature of the coke and products, as well as the quantity obtained, depends on quite a large number of factors. Amongst these are:—(1) The nature of the coal—its volatile matter, coking property and agglutinating power; (2) its dryness; (3) size of coal, and its compactness in the oven; (4) the intensity and uniformity of its heating; (5) speed of removal of the gases from the oven; and (6) the width of the oven.

The Nature of the Coal

It will be obvious that coke to be used for foundry purposes should be made from coal that contains the minimum quantity of sulphur and ash, and that it should have correct coking or fusing property.

It will be understood that coal as obtained from the earth is seldom very pure. It is always mixed with varying amounts of shale and fireclay, stones, sulphur bodies as pyrites and marcasites and calcite.

The larger and more visible pieces of these impurities are removed by hand picking, and those too small to be hand-picked are removed by crushing the dirty coal and washing it with water or by passing the dirty coal over vibrating tables in a strong current of air. The fact of the impurities being heavier than the pure coal renders separation possible.

* Extract from an Address given before the Lancashire and West Riding of Yorkshire Branches of the Institute of British Foundrymen.

XUM

The principal effect of heating the coal, as has been said, is to cause the fusible constituents to melt. The plastic mass then becomes inflated to a kind of froth by the passage through it of the evolved gases. The mixture swells considerably and the infusible particles become partially enveloped by the plastic substance, and as the heating proceeds the fused constituents, as well as the infusible ones, lose their volatile matter. The frothy mass solidifies in the shape of minute particles or cells, and we have the light, porous substance to which is given the name of coke.

The bottom bed of the Mountain Mine seams, from which, after careful blending, Lancashire foundry coke is made, is an ideal coal for this purpose. Its analysis is C, 86.36; H, 5.36; O, 5.92; N, 1.82; S, 0.56; P, 0.012, and ash 1.81 per cent.

Intensity and Uniformity of Heating

It is most important that carbonisation should be carried out at exactly the proper temperature for the particular coal, and that all parts of the coal should be submitted to the same temperature. After correct composition of coke, the most important property of coke is probably its uniform structure, and this can only be achieved by great uniformity in heating. Coke made in an oven which has different temperatures at the top and bottom, or at the centre and ends, is most unsatisfactory in use. That made in the cooler parts will be soft and likely to crumble; that made in the hotter parts may be brittle and small, whereas coke made in an oven at the correct temperature throughout will be uniform in its properties.

The properties of combustibility and reactivity to air depend largely on the correct and uniform carbonising temperature. Upon these depend the ease with which the highest temperature can be attained in the cupola in the shortest time. It is, therefore, of the highest importance that foundry coke should be made in ovens wherein these properties may be achieved. Generally it may be said that the highest temperature which silica bricks will economically withstand is required. The coke should be discharged immediately it is all carbonised, and not allowed to bake in the oven, as this renders it brittle and unduly incombustible.

The coke when made is sorted and loaded by hand so as to ensure the very best pieces of the coke being delivered.

The composition of foundry coke made at Altham is: Moisture, 1 per cent.; volatile matter, 0.75; sulphur, 0.54; ash, 7.50; fixed carbon, 90.20, and phosphorus, 0.01 per cent. The shatter-test index is 94 to 98.

Speed of Removal of the Gases

The gases first liberated from the coal by heat in the oven do not by any means pass away from the oven in the form that they are evolved. In passing through the hot layers of coke already made they become decomposed into simpler bodies and free carbon. This free carbon, or graphite, is deposited on the natural coal skeleton and gives it a hard, shiny appearance, which has been likened to the surface of a cauliflower.

The quicker the gases can be removed from the oven the less this action will take place. A suction or at least a very little pressure is therefore maintained in the oven when carbonisation is in progress. The general effect of heating the coal in a closed vessel is, then, to separate the coal into two parts: (1) gases which are drawn out of the oven and (2) the residue coke. The crude gases consist of: steam, coal-tar hydrocarbons, ammonia and other gases, crude benzoles, etc., and illuminating gas.

The crude, hot gases leaving the ovens are first cooled by water-cooled condensers, whereby crude coal-tar is precipitated. Then the gas is washed with water in tall scrubbers, whereby ammonia and other substances are extracted from it, ammoniacal liquor being obtained. Then the gas is washed with creosote oil, whereby benzole and other hydrocarbons are extracted. Finally, the gas is despatched to oxide-of-iron purifiers, where it is freed from sulphur compounds, and thence it goes to the towns for public utility purposes.

The general characteristics of the products obtained from coal by carbonising in either gas-works retorts or coke ovens are very similar. From 100 parts of coal there are obtained approximately 18 parts of illuminating gas, 1½ parts of crude benzol, ½ part of ammonia, 10 parts of water, 5 parts of tar and 65 parts of coke.

Coal tar is a thick black liquid, much heavier than water. It consists of a mixture of a very large number of substances having widely different properties. Some of these substances are liquid and others are solid, some are of an alkaline nature, some are acidic and others again are of a neutral character. The processes of distillation by fire, crystallisation of certain portions by cooling, and purification by chemical treatment of the oils are all necessary to effect the separation of the constituents of coal tar in such a form as to render them available to industry.

Distillation of coal tar consists in heating it to a final temperature of about 360 deg. C. in steel stills having a capacity of 20 tons. Vapours are evolved which become liquid or solid on cooling, and pitch remains behind in the still. The fractions which distill off at the various prearranged temperatures are cooled and collected in different receivers. The fractions usually collected are as follow:—(1) Light oil, containing benzene, toluene and naphthas; (2) middle oil, containing carbolic acid, naphthalene, etc.; (3) creosote oil, containing cresylic acid, naphthalene, etc.; (4) anthracene oil, containing anthracene, phenanthrene, carbazole, etc.; and (5) pitch.

Ammoniacal Liquor and Products Derived Therefrom

Ammoniacal liquor is a dark-brown liquid, with a pronounced tarry and ammoniacal odour. It consists of ammonia, its salts and many other substances dissolved in water. As obtained from the scrubbers, it contains about 2 per cent. of real ammonia, and this is present partly in the free state and partly combined with certain acids. Cyanides, sulphides and carbonates are also present.

Cyanide Manufacture.—In some works the crude liquor is treated with sodium carbonate and salts of iron. On filtering and evaporation, there are formed crystals of yellow prussiate of soda (sodium ferro-cyanide).

Sulphate of Ammonia.—At most works the ammonia of the liquor is converted to sulphate of ammonia or pure liquor ammonia in the following way:—The liquor is boiled with steam, then mixed with lime, and further heated, all ammonia being thus driven off in the form of a vapour. This vapour is forced into a lead-lined saturate containing sulphuric acid. Combination between the acid and the ammonia takes place and crystals of sulphate of ammonia are formed. The crude crystals are washed with water containing a little ammonia and dried in rotary cylinders. Pure white, neutral, dry crystals of sulphate of ammonia are thus obtained. At the coal-carbonising works of Great Britain there are annually manufactured upwards of 400,000 tons of sulphate of ammonia. All of this is employed in agriculture as a fertiliser. It is exported to many parts of the world.

Liquor Ammonia.—When pure ammonia is to be manufactured the ammonia vapour from the stills is dissolved in pure distilled water instead of being collected in sulphuric acid. A very strong solution is obtained in this manner, containing about 35 per cent. of real ammonia and having a specific gravity of 0.880.

Benzole. — The mixture of creosote oil and benzole obtained from the scrubbers is separated by boiling up with open steam. The creosote oil is used again to dissolve more spirit in the scrubbers, and the crude benzole is set apart for refining. The crude benzole is an evil-smelling mixture of a large number of aromatic compounds. These, when heated, boil at different temperatures, and, therefore, to effect their separation, the mixture is subjected to distillation in steel stills in which the temperature can be gradually raised.

The rectification of benzole, therefore, consists in separating the mixture into its pure compounds by distillation, washing these compounds separately with concentrated acid, then with much water, with caustic-soda solution, and again with much water, and, finally, a further re-distillation. By this treatment there are produced, benzole, toluole, xylole, solvent naphthas, etc.

We have now obtained some idea of the manner in which coke, coal tar, benzole, ammonia and town gas have been obtained from coal by carbonisation.

And, further, how by suitable treatment and purification other products, such as benzole, toluole, naphthalene, anthracene, carbolic acid, etc., have been separated. Coke manufacture gives a great many substances valuable in the arts, in industry and in medicine may, in turn, be manufactured from them, such as:—Medicines, Dyestuffs, Perfumes, Wetting Chemicals, Explosives, Surgical Aids, Ammonia Compounds, Photographic Materials, Disinfectants, Rot Proofs, Germicides, Road Tars, Paints, Wood Stains and Preservatives, Solvents, Fuels, Firelighters and other substances used for a variety of purposes.

It should be clearly understood that the organic compounds comprised in this list are not actually present in coal, and only a relatively small number are present in the first by-products obtained from it.

The by-products should be looked upon as the starting point from which the more complicated substances may be manufactured. In their production all the physical and chemical operations known to science are called into use: distillation, filtration, sublimation, crystallisation, refrigeration.

By these means chemically pure solids and liquids are obtained—these are then acted upon by strong acids and alkalis, at high and low temperatures and pressures—and there are then a class of substances called intermediates. There are over 600.

The intermediates themselves are now treated with strong acids and alkalis, oxidising and reducing agents. Sometimes they are combined with each other and with other bodies, such as alcohols, etc.

Vote of Thanks

MR. J. HOGG (Burnley) proposed that a hearty vote of thanks be accorded to Mr. Hollingworth for his extremely interesting and informative Paper.

MR. A. PHILLIPS (Manchester) seconded the vote of thanks.

The vote of thanks was carried unanimously by acclamation.

DISCUSSION

MR. A. SUTCLIFFE (Bolton) asked what was a reasonable amount of fines to be expected after hand riddling, and how did Mr. Hollingworth account for the frequent discrepancies which occurred between the analysis report of a coking-plant chemist and that of the chemist at the foundry.

MR. HOLLINGWORTH observed that it was quite correct to state that, in order to make a good Beehive-oven coke, a good raw material must be used. There was, however, no doubt whatever that a better coke could be made from a patent oven than from one of the Beehive type. The day of the Beehive oven was gone, never to return. It was no longer economical to use, and the particular characteristics of the type of coke it turned out were no longer required. To continue to make that type of coke would be a

crime against the general economy of the country and would undoubtedly result in a loss of trade and less employment for all concerned in the foundry industry. Patent-oven coke was now reaching a quality which the Beehive type never approached.

With regard to fine coke, there was not more, at any time, than ½ per cent. of dust in the coke produced by the company. It was the nature of coke to be slightly friable on its external surfaces, and therefore if it was only moved a few yards tiny particles would fall from it, while if taken sufficiently far away possibly 1 per cent. or even a little more, fine coke would result. Everything possible was done by the company to keep out fine material from the coke.

With regard to varying analyses, all he could say was that those which were issued by the company's chemists were correct. They were arrived at by highly-trained chemists who were accustomed to do them. A chemist in another industry, who was accustomed to analyse, say, iron or iron ore, was not necessarily expert at analysing cokes, coals, and fuels generally. The apparatus which it was necessary to employ for the purpose was costly and difficult to use.

Carbon Pick-up

MR. A. L. KEY (Manchester) said he had found from experiment in trying various grades of coke, all the conditions being equal, namely, the same kind of material charged into the cupola, similar blowing conditions, etc., that one metal would take more carbon from one particular coke than it would from another. He wondered whether this was due to some mechanical action or to some chemical reaction. Did the coke manufacturers know the reason for this, or, if not, was it worth their while to pursue an investigation into the subject? If a particular coke could be guaranteed to have a minimum carbon pick-up as contrasted with all other cokes, then that would be coke that foundries would purchase. Personally, he bought cokes which gave him considerably less carbon pick-up than any of the other cokes he had tried, although the heating value of some of the other cokes was better. The main consideration was the total carbon in the iron.

MR. HOLLINGWORTH said it was definitely one of the problems of the industry. There was not a great deal of definite information as to why the carbon pick-up should vary with different cokes, but much research work had been undertaken with regard to the matter during the past six months. The company's coke had been tested in comparison with several other well-known cokes in the country. There were a great many theories as to why the pick-up varied. He assumed that the problem had arisen owing to the present practice of making higher-class qualities of iron which were of a semi-steel nature. Speaking as a chemist, it appeared to be the case that the amount of carbon which an iron would pick up depended upon three or four different factors. The quantity did not appear to have any relation at all to the calorific value of the coke or its chemical composition, but he certainly thought it had something to do with the physical condition in which the coke was supplied to the cupola. The physical composition of coke was really a complicated matter. Points to be considered were the size of the cells, the strength of the walls, the toughness of the mass, the occluded gases in the coke, and the possible presence of metals which exercised a catalytic action in the process, all of which, in other words, had reference to the combustibility of the coke. He did not think that at the present time anyone was in a position to state what factor operated nor to what degree. Furthermore, it was to be understood that coke, as the company made it, was not special to one particular kind of iron. It had to be used for all kinds of cupolas, and probably for the manufacture of many grades of iron. Even when scientists had done their best, they might not be able to produce a coke which would be the best for all the purposes for which that coke was going to be used. It might be, and he believed it was the case, that there was a peculiar group of properties connected with a particular coke that caused its carbon to be less soluble in iron and therefore resulted in a lower carbon, pick-up. He assumed that a minimum quantity of carbon was desirable. His company were endeavouring by uniformity of heating, sufficient heating, but not too much heating, to produce a coke which possessed, as far as possible, an average high level in properties. By having regard to specific gravity, porosity, combustibility and reactivity, they were able to preserve the most desirable features in the company's coke which it was at present possible for it to possess.

MR. A. L. KEY mentioned that in the case of the particular cokes he referred to, and their chemical composition in relation to carbon content, although there was only a difference of 0.5 per cent. total carbon in the coke, yet there was a lower pick-up with a higher carbon content. This result had caused him to assume there was some mechanical action; in other words, that the physical character of the coke controlled the reaction.

MR. A. JACKSON asked if Mr. Hollingworth could state what was the difference between the by-product coke and the Beehive type concerning which the older foundrymen seemed to speak so fondly. Apparently, it had a strong cellular tissue and a good hot iron could be obtained with little trouble. A thoroughly strong cellular tissue appeared to have a decided advantage. Was it not possible, in the present-day making of by-product coke, to imitate that strong cellular tissue instead of producing what appeared to be a very minute tissue obtained probably through compression in the ovens.

Another problem was smalls, coke which was under 2 in. across was of very little use in the cupola, because it choked up, and made "kishy" iron.

Was any form of "shatter" test adopted at the Altham plant for this particular type of coke? One of the strong points with regard to cupola working was that the coke used must be capable of withstanding a considerable weight of metal without breaking.

He had noticed that some coke had a particularly fine silvery appearance at its surface. He would like the cause of this to be stated.

It could be taken for granted that there was not much sulphur in coke produced at Altham. Was there any way by which the unaided eye could detect a sulphur content in coke beyond a certain amount? It was generally assumed among foundrymen that if a yellow rust was noticeable on the surface of the coke it was of inferior quality.

MR. HOLLINGWORTH said that he, personally, was not able to declare by means of the unaided eye whether a coke was high or low in sulphur content. The rust spots which had been referred to had been analysed many times and had been found to consist of iron oxide which was absolutely harmless. The shiny mirror-like appearance which was sometimes associated with coke appeared to be due to a deposition of carbon on the skeleton of the coke, or the residue of the coke, caused by cracking of the hydrocarbons in the oven. If there was extraordinary pressure and a very high temperature in the oven, and some of the valuable gases had been subjected to the pressure, those gases would decompose into substances one of which would be carbon in an extremely finely divided condition, almost molecular in size. This carbon being sprayed, as it were, upon the surface of the coke gave it a white, silvery appearance. Whenever that silvery appearance was noticeable the observer could be quite certain that it was due to the purest possible form of amorphous carbon.

The "Shatter" Test

The "shatter" test, as adopted at the Altham plant, was a very severe one, and was made daily. It was found that 96 to 98 per cent. of the coke would not pass through a 1½-in. screen. Only about ¼ per cent. would pass through a 1-in. screen. There were very few other cokes produced in the country which would withstand such a severe test.

Beehive and Patent Coke

It was only necessary to envisage the method of manufacture of Beehive coke and compare it with that adopted at Altham to realise that there must necessarily be a considerable difference in the results obtained. In actual practice it had been found over and over again that patent-oven coke was as good as, or better than, Beehive coke. Much depended upon the attitude of the user. Most people overlooked greater economic conditions when they were thinking about their own. If industrialists unwisely demanded a product which was either unnecessarily poor or unnecessarily perfect, they were, in reality, wasting the country's money and its labour power. Going back to the old Beehive system of coking would now never be tolerated. In the old days he had seen 550 Beehive ovens, placed in several rows, carbonising something like 3,000 to 4,000 tons of coal per week. All the tar, benzol and ammonia was belching into the air, with the result that the vegetation for miles around was either dying or dead. Nowadays, there were legislative restrictions with regard to what might be poured down the sewers, into the rivers, or into the atmosphere. Furthermore, it should be recalled that the heat in the Beehive oven had to penetrate a mass of probably some yards in thickness. It was a very slow, uneconomic process. The consumption of heat was enormous compared with the amount of work accomplished.

Sulphur in Coke

MR. F. HARRIS (Padiham) inquired whether the sulphur content in the coke was entirely subject to the sulphur content of the coal, or was it subject to alteration during the burning process?

MR. HOLLINGWORTH said that, obviously, the sulphur in the coal had a considerable bearing on the sulphur in the coke. The sulphur in the coke was present partly as sulphide of iron, namely, pyrites, or in a finely-spread variety called marcasite, or as calcium sulphate or gypsum. There was also some which went to form the actual substance of the coal, and which had been introduced through vegetable matter. During the carbonising process a great deal of the sulphur was driven off. The resultant coke represented a weight or volume of 70 per cent. of the original coal. All the sulphuretted hydrogen which was abstracted at the gasworks purifiers came from the original sulphur of the coal. If, for the sake of illustration, there was half-a-ton of sulphur in 100 tons of original coal, there would not be anything like half-a-ton of sulphur in the coke produced from that coal; actually, there would only be about 6 cwts.

The discussion then closed.

Surface Hardening of Aluminium Alloys

In using aluminium alloys it is often desirable to increase the hardness of the surface. The engineers of the Aluminium Company of America have gone far in this direction in their new electrolytic treatment (Alumilite process) of their Lo-Ex alloy. The equipment for the treating resembles that of electroplating, but the oxide surface resulting is made from the parent metal and is not a layer of material deposited on the surface. Consequently the finish has a high tenacity combined with the hardness and smoothness of a fine bearing surface. All machining and grinding are done before treatment, and the thickness of the Alumilite finish can be controlled uniformly and within close limits. Such a treatment of this alloy is finding its largest use in the improvement of automobile pistons, although such an integral hard surface is of potential value to many other industries.—"Iron Age."

Vitreous Enamelling Plant Conduct

DISCUSSION ON MR. J. T. GRAY'S PAPER

The discussion on Mr. J. T. Gray's Paper on "Some Aspects of Plant Lay-out and Production," which was reproduced in our last two issues, was rendered really valuable by the remarks of an American visitor, Mr. Rosenberger, on recent abrasive developments in his country. Mr. B. B. Kent was in the chair.

The CHAIRMAN, commenting upon the point that the suppliers of equipment had awakened to the fact that enamelling was worth being studied and warranted the design of special equipment, suggested that they might design a better motor for the vibrating sieve. The motor fitted to this apparatus so far was of more or less open type, and no matter how careful the operators were, there was a certain amount of slop getting into the motors. He believed it was the usual experience that such motors went wrong about once a week, due to enamel slop getting on to the windings. There were totally-enclosed motors on the market, and they might with advantage be used on vibrating sieves.

Mechanising Pickling Plants

MR. V. C. FAULKNER (Past-President, Institute of British Foundrymen), who assumed that in the pickling plant the tops of the vats were open, suggested that that was a poor system. A better system was one in which the vats were all of the same size, provided with lids, the sheets to be treated being suspended beneath the lids. Thus, once a sheet had been suspended beneath a lid, the lid carrying the sheet could be transferred readily from one vat to another without further handling of the sheet itself.

Mr. Faulkner disagreed with some of Mr. Gray's remarks concerning mechanisation. It had been suggested in the Paper, amongst other things, that large storage space was required; but Mr. Faulkner suggested that in any well-organised mechanised system the whole of the material should be carried on a conveyor, which itself acted as a store, no further storage space being required. For instance, he failed to see why conveyors should not be installed in drying rooms.

De-Enamelling Sheet

MR. A. B. KENT, commenting upon Mr. Gray's reference to the fact that in one or two plants there were a few rejects, said that that was all very well when enamelling cast iron, for the rejects could be sand-blasted and used again. But the problem was more difficult when one was enamelling sheet iron. Even if there were only 2 per cent. of rejects, in a plant dealing with about, say, 6,000 pieces per week, a good many thousand would have accumulated by the end of the year. Therefore, he asked if Mr. Gray could make any suggestions concerning the de-enamelling of sheet iron.

Rotary Frit Furnaces

MR. CHIFFEY, who had attended the meeting of the Midland Section of the Institute a few days previously, when Mr. J. H. Davidson had presented a Paper on "Frit Kilns," said that only one of those who had entered into the discussion there had thought that the reverberatory type of furnace was superior to the rotary type; all the others appeared to think that the rotary type was superior, for the reason that the oil consumption was better, or that the speed was greater, or that a better product was produced. The reason given for the improved product was the better mixing during firing. It was pointed out that it was almost impossible to stir a batch in the reverberatory type of furnace, and, therefore, the heat was carried through from the top of the batch to the bottom, which meant obviously that the top of the batch was over-melted and the bottom was slightly under-melted; on the other hand, in the rotary type of furnace, the whole of the batch was subjected to practically the same degree of heat.

MR. W. TODD (Midland Section) endorsed Mr. Chiffey's statement that the general consensus of opinion at the Midland Section meeting at which Mr. Davidson's Paper was presented was condemnatory of the stationary type of melter. Apparently, Mr. Gray's argument was that oil burners of the needle type, where the line of injection was on the axis of the revolving barrel, were perfectly correct. In the more modern type of oil burner, however, the flame was injected fanwise, the angle being anything from 90 to 120 deg., so that it was directed to the outside walls, round which the batch was moving, rather than to the centre; hence, there was less possibility of any material loss due to the batch being blown through the orifice at the opposite end.

Refractories for Frit Furnaces

Comments were made also by Mr. Davidson on varying types of melters, including several Continental ones, and he had instanced several types in which approximately 800 to 1,000 melts per lining were obtained. On that point there had been quite a contentious argument. A question had been asked as to which was the best type of refractory. But many factors had to be considered, apart from the type of refractory. It had been pointed out that with enamel for cast iron, when a moulded type of refractory was used, the number of melts per lining was only 180; when using an arched type of brick, to his surprise, the figure was 317. In the case of sheet iron, when using moulded bricks the number per lining was 250, and with the arched bricks it was 452. The experiments were being continued, and naturally, further tests were being confined to the arched type of brick, using the different grades of refractory. This was a most important factor, and Mr. Todd asked if Mr. Gray had any information regarding the number of melts obtained per lining in the different types of rotary melters.

MR. CHIFFEY asked Mr. Gray how he could get large blocks of frit from the furnace, for use in a mill; it seemed that as soon as the blocks cooled down they broke into small pieces.

MR. GRAY, replying to the chairman's question concerning the motor on the vibrating sieve, said there were over one hundred of these machines at work throughout the enamelling industry, and very little trouble was experienced in the direction indicated. In a number of shops a wrought-iron shield had been placed over the motor in order to prevent any enamel splashing in.

Pickling Shop Practice

Commenting upon Mr. Faulkner's reference to the covering of the pickling tanks, he pointed out, in the first place, that in the modern pickling room there were no noxious fumes arising from the pickling tank proper—there was only one such tank, the others being for water, soda and borax—and covering would represent an added complication, introducing no advantage. He believed anyone operating a pickling room would agree with this, except in cases where hot sulphuric acid was used, and in such cases they were generally housed within special partitions. The use of hot sulphuric acid is growing less popular.

Mr. Gray also did not think that Mr. Faulkner's suggestion concerning the use of conveyors in such a way as to dispense with storage space was applicable to enamelling shops. In a completely mechanised plant, the operations following enamelling—such as assembly, and so on—would have to be done on conveyors; of course, that was done in a number of industries working with enamelled goods. But one must bear in mind that every operation in an enamelling shop was dependent to a very considerable extent upon the human element, and he felt bound to say that, until we could overcome that difficulty, complete mechanisation had its drawbacks—unless the market was always available to absorb the output. He believed that had been the experience in other countries.

In reply to Mr. A. Kent, he said many systems of de-enamelling had been tried, and he was afraid that in the processes put forward so far the cost of de-enamelling had been greater than the value of the stampings themselves when recovered. At the moment, he only knew of one plant where they were sand-blasting for the de-enamelling of sheet iron, and this was being carried out at a low pressure. There had been many discussions regarding flint *versus* steel grit, and he believed that so far flint grit was the most suitable medium for the de-enamelling of steel sheets at low pressure. He was quite prepared to accept the view, mentioned by Mr. Chiffey, that the rotary furnace was definitely more efficient than the old type of direct-fired or drastically-fired reverberatory type; but there was still much to be said for a well-designed type of stationary reverberatory furnace. Many enamellers of long experience had told him often that, when using another type of furnace, the enamel did not seem to be so good as when they had used the older type; that was his reason for putting forward the suggestions concerning the high velocity of the gases in the rotary type and the advantage of the static type of furnace due to the soaking period. The capacity of frit smelters was a rather important matter. Speaking in terms of weight of the raw batch, and not frit output, he said he had so far not found a user of a rotary furnace who could use it up to its rated capacity. It was generally found that it was necessary to work well below the rated capacity in order to secure efficient working. In some cases where the rated capacity was 800 lbs., only 650 lbs. could be efficiently charged per batch. He had no information then available as to the best type of refractory linings used in rotary furnaces, but on the basis of the best figures stated by Mr. Todd of 317 charges per lining, which he assumed was on a 500-lb. melt, the total weight dealt with was 158,500 lbs. per lining, whereas on the reverberatory type mentioned by Mr. Gray in his Paper 500 melts of 2,000 lbs. each were obtainable, making a total of 1,000,000 lbs. of raw material, or about 885,000 lbs. of frit—practically six times as much. These latter figures were based on soft cast-iron enamels, which had a greater eroding effect on the refractory lining than some other types of enamel. In view of Mr. Thomason's experience, Mr. Gray asked whether he would deal with the question as to the methods of extracting the large rocks of enamel from the smelter for use in dry grinding mills.

MR. THOMASON said that it was the practice of some firms to run the material out on to steel trays having a thin coating of china clay, the purpose of the china clay being to prevent the material adhering to the trays. In that way they were able to produce anything from splinters to chunks of rock, and, inasmuch as they were all of the same composition, they could either be ground down to a powder or used as grinding balls. It was claimed by some people that even the small portions of porcelain yielded in the grind were sufficiently important to warrant using grinding balls or blocks of exactly the same composition as the material that was being ground. Of course, they did wear down; but the enamel was usable.

MR. MCCALLA said that he had tried making these grinding balls many years ago, having made a good many costly experiments in conjunction with the late Dr. C. H. Thompson, but they had given it up as impracticable.

MR. KENNETH HILL, referring to sand-blasting, said that one firm was using a No. 16

angular steel grit, at a pressure of 60 lbs. per sq. in. He asked if Mr. Gray considered that if the pressure were increased to 80 lbs. per sq. in., and if a finer grade of metallic abrasive were used, a larger output would be achieved.

MR. GRAY replied that the pressure in the plant referred to was actually 60 lbs. per sq. in. at the nozzle; it was regulated to blow off at the receiver at about 65 lbs. per sq. in. Finer shot and coarser shot had been tried, but it was found that from the point of view of all-round efficiency —preventing clogging and facilitating the general working—No. 16 grade was the best. He could not say definitely, but he believed that No. 16 shot was the grade generally used in enamelling sand-blast departments.

MR. GRAY, JUN., replying further to Mr. Hill's question, said that finer shot and higher pressure had been tried, and it had given an apparently better cleaned casting; but its use was discontinued because it resulted in more warping of the casting than was experienced when No. 16 shot was used at 60 lbs. pressure. The finer steel grit, which he believed was No. 18, was tried at a pressure of 80 lbs. per sq. in., but under those conditions warping occurred.

The CHAIRMAN extended a hearty welcome to Mr. Rosenberger from America, and invited him to discuss American practice regarding the use of steel abrasives.

MR. ROSENBERGER (of the Pangborn Corporation), after expressing his appreciation of the Paper, spoke with regard to the de-enamelling of steel sheets, and said it had been done quite successfully in America in the case of sheets as light as 18 gauge. For that work a pressure of about 80 lbs. per sq. in was used, and the grit was far finer than that which it was the custom to use in this country; the grade was from 70 to 90. But there was a technique in de-enamelling thin sheets and light castings by means of steel grit; the nozzle must be held a fair distance from the work, in order to avoid warping. If Mr. Gray, jun., held the nozzle farther from the work and swayed the nozzle over the work faster, he would not only clean it more quickly but would also avoid warping.

MR. GRAY, JUN., said he had been referring to de-enamelling on a rotary table, where the height of the nozzle was fixed.

MR. ROSENBERGER replied that he did not know what kind of rotary table Mr. Gray had available; but in America there were three different types, to suit different kinds of work and different operations. It was quite possible that in Mr. Gray's table the nozzle was too close to the work, having regard to the combination of abrasive and air pressure used. He was surprised to hear that a lighter abrasive should have any more tendency than a coarse abrasive to warp the work treated; in his experience the results were the opposite. There must be some peculiar castings in England!

MR. J. T. GRAY asked if Mr. Rosenberger could give any news of the development of the airless sandblasting process.

Centrifugal Blast Machines

MR. ROSENBERGER replied that the centrifugal blast machine was nothing more nor less than a paddle wheel, in effect, into which the abrasive was fed (generally at a point near the hub), and was thrown out by centrifugal force around the periphery. A method had been developed recently by two different concerns, almost simultaneously, for controlling the point on the periphery from which the abrasive was discharged. That control had been effected in the laboratory about a year or eighteen months ago, and had since been accomplished in the factory. In Mr. Rosenberger's opinion, it was too early yet to say whether or not the centrifugal blast would in the long run clean the work more efficiently—by which he meant with better overall efficiency, including cost—than air blast. It remained to be proved that the extra maintenance cost of the centrifugal-wheel plant did not far exceed the cost of the extra horse-power required when using compressed air.

Disadvantages of Airless Machines

An argument against the centrifugal blast was the comparatively limited application. When using air blast, one could place the nozzles where they were needed; for instance, on an automatic machine, one could change the size of nozzle to accommodate certain surface conditions, such as spots which were more difficult to clean than others. With the centrifugal wheel, there was an oblong field, probably 30 or 34 in. long and 6 in. wide at the widest section, tapering to a point at each of the two ends. At approximately one-third the length from one end there was a very intense blasting action, due to the fact that at that point the abrasive was thrown from the wheel at right-angles to the work. Theoretically, that occurred at one single point only, and for a fair distance on either side of that point the abrasive was still thrown on to the work at such an angle as to give fairly good blasting; the greater the distance from that point, the less was the efficiency. The efficiency changed with the angle at which the grains of abrasive material hit the work—the smaller that angle, the less the efficiency. If the grains of the abrasive travelled parallel, or practically parallel, with the surface of the work, there would be hardly any abrasive action, but only a light scouring. Bearing those facts in mind, one could determine whether it was possible to secure uniform distribution of blast by the centrifugal wheel on the particular work under consideration.

MR. KENNETH HILL, commenting on Mr. Rosenberger's advice to use a very much higher pressure and a very fine grade of grit for de-enamelling, asked if it were really economical to use such small grit. It appeared to him that it would be exhausted very easily, so that the economy effected by using it would be neutralised by the fact that one would have to use so much of it.

Using up the Fines

MR. ROSENBERGER replied that the sand-blast equipments he had seen so far in this country were not at all adapted to the use of fine chilled iron grits. Nevertheless, if enamellers wished to achieve the highest efficiency in plate blasting, they would have to come sooner or later to much finer grades of grit than they had used so far; with grades up to about a 90 grit, which was quite fine, they would obtain faster cleaning than with coarser grit on any kind of work. In America, there was often recommended a mixture of two, and sometimes three, different grades of grit for certain work, it being recommended also that, as the grit wore away and the fine material was wasted, the user should replenish with the most coarse of the three grades, because all the grades would wear away gradually, and by replenishing with the coarsest material one maintained an effective mixture. The blasting was much faster with such mixtures than with one size of grit.

In order to use fine grits efficiently, it was essential to have a first-class abrasive reclaiming system, and particularly an abrasive separator which would take out all the silica dust, coarse sand or moulding sand which had been left on the castings, but which would not remove even the finest usable particles of steel abrasive. He did not believe such a separator was available in Europe; but it was not until that had been evolved in America that the industry there had made any headway at all with the use of steel grit.

Another factor which would have to be examined more carefully before long was the moisture condition of the sand-blasting grit. The finer the grit, the more trouble would arise from the presence of moisture.

MR. GRAY, JUN., pointed out that until a few years ago flint grit was used almost exclusively in this country in the enamelling industry; the reasons for changing over to the use of chilled-iron grit were that the latter was cheaper to use, and enamellers did not experience the troubles that had arisen due to the dust from flint grit. He suggested that if a very fine steel grit were used, which would give rise to dust, one should derive little advantage from using it in place of flint grit, for he believed the majority of people who had had experience of both flint grit and chilled-iron grit had found that the flint grit really gave the best results.

Flint and Finish

MR. ROSENBERGER replied that many people in the United States still preferred to use "flint sand," as they called it; but their preference was due mainly to the fact that the castings treated with it had a brighter appearance than those treated with chilled-iron abrasive. However, one must not lose sight of the fact that 1 lb. of sand would create 1 lb. of dust, whereas a ton of steel would not create any dust except that arising from the slight wear of the chilled-iron particles, and that dust was collected in the dust-collecting system. It was calculated that a chilled-iron abrasive would wear away only to the extent of about 0.1 per cent. per day, *i.e.*, if one used 100 lbs. of chilled-iron abrasive for a day, only about one-tenth of a lb. would be lost due to wear.

Another reason for using chilled-iron grit instead of sand was that sand would give rise to silicosis, whereas metallic abrasives had not the same effect on the lungs. Iron was absorbed by the system and dissolved.

So that there were two main reasons why chilled iron should be used instead of sand. The first was that it cleaned better than sand, because it had greater specific gravity and hit the work harder; secondly, it was less harmful to the operators than was sand.

Norbide

MR. V. C. FAULKNER asked for Mr. Rosenberger's experience of the use of nozzles made of "Norbide."

MR. ROSENBERGER replied that such nozzles had been in commercial distribution for less than a year. He did not know how many were in use in America, but, at the price paid for them, users had found that by using them they effected a substantial saving as compared with the use of the ordinary hard iron nozzles. They gave a life of well over 3,000 hrs., using chilled-iron grit; they were guaranteed to maintain their condition for 1,500 hrs. with steel grit.

MR. J. T. GRAY said it was his experience, in connection with a number of plants, that when chilled iron grit became really fine it appeared to give a better surface to the castings treated than when it was coarser; but, from the point of view of the enameller, that so-called improvement was only an *apparent* improvement. Sand-blasters were very fond of closing the exhauster gates so that the fine grit and dust came round to them again and gave the castings a very nice appearance; although the castings looked really clean, they had not in fact been sand-blasted, but merely cleaned, and the absence of real sand-blasting was detrimental to enamelling. That was one reason why we had to consider very carefully the problem of screening steel grit, to keep it up to standard.

MR. ROSENBERGER replied, with the best will in the world, and without any desire to be critical, that once they in this country were able to secure the right conditions for using chilled grit, experience of its use would be very different from the experience they had had so far. He did not believe there was a single installation in England, Germany or France which really applied the proper conditions for securing 100 per cent. benefit out of the use of chilled iron grit. The same difficulties had been experienced for years in America, and they had not achieved real success with it until they had perfected the reclaiming or separating system. By simply introducing fine grit into the present sand-blasting installations here one would not secure proper results, and he suggested that if

(*Concluded on page* 147.)

The International Meehanite Metal Research Institute

Last week, on Wednesday and Thursday, members of the Meehanite Metal Research Institute held their first gathering in Europe at the Charing Cross Hotel, London, Mr. E. H. Jones presided over the four sessions and Mr. R. B. Templeton (Ealing Park Foundry, Limited) acted as secretary. Amongst prominent personalities present were Mr. John Cameron, J.P. (Past-President of the Institute of British Foundrymen, and Vice-President of the British Cast Iron Research Association), Mr. R. M. Pease and Mr. N. E. Rambush (Ashmore, Benson, Pease & Company, Limited), Mr. H. M. Thompson (Winget, Limited), Mr. J. Hay (G. M. Hay & Company, Limited), Dr. Pfannenschmidt (Stotz Company), Dr. Gossmann (Fürstlich Hohenzollernsche Hüttenverwaltung), Mr. A. Campion and Mr. E. M. Currie. Apologies were received from the French licensees and Dr. Guido Vanzetti.

On the Wednesday evening the members were the guests of Mr. Jones at a banquet held at St. Stephen's Club. Mr. V. C. Faulkner, Past-President of the Institute of British Foundrymen and Editor of THE FOUNDRY TRADE JOURNAL, was the guest of honour. In his address, Mr. Faulkner congratulated the new Institute on the splendid way in which the members were co-operating. He understood that during the day's sessions, which lasted from 9.30 a.m. to 6 p.m., they had studied and discussed a matter of twenty-five Papers, emanating from all the principal industrial countries. He made particular reference to the pioneer work of Mr. Oliver Smalley in the fundamental properties of cast iron. With the successful launching of Meehanite and other high-duty irons, the speaker suggested that the time was ripe for a request to be made to the British Standards Institute for preparation of standard specifications to include tensile strengths ranging beteen 20 and 30 tons per sq. in. A suggestion was also put forward that the Institute might collaborate with the Foundrymen's International Technical Committee for enriching the international foundry dictionary, which was at present occupying the attention of the latter. Mr. E. H. Jones, in reply, said that good note had been taken of the advice tendered by their guest. He was satisfied that by the pooling of the technical data acquired by licensees in all parts of the world with such unqualified frankness as had been shown that day, a beneficial influence would be exerted, not only upon the practice carried out in the individual works of their own members, but also upon the whole of foundry technology.

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it is perhaps unkind to suggest that more might have been undertaken. It would, however, be very helpful if, in future monographs and in any future edition of this present monograph, a classified list of pertinent patents were given. Reference is made to a few patents, but in the preface the authors state that no systematic study of the patent literature has been made. In view of recent publications of classified patents, it would really not have entailed very much more work to have included particulars of the analyses patented in the leading countries of the world, and that would, if possible, have made the book still more valuable. The inclusion of such a section would also, perhaps, have directed the authors' attention to a use of copper which may in the near future revolutionise certain branches of the steel trade, viz., the utilisation of copper as a substitute for the whole of the nickel in austenitic nickel-chromium steels.

J. F. K.

Book Review

Alloys of Iron and Copper. By J. L. Gregg and B. N. Daniloff (Alloys of Iron Research, Monograph Series). Published by McGraw-Hill Publishing Company, Limited, Aldwych House, London, W.C.2. Price 30s. net.

This is the fourth Monograph that has been prepared at Battelle Memorial Institute as a part of the Institute's contribution to Alloys of Iron Research and, like its predecessors, it is a very valuable contribution and one than should be on the shelves of every metallurgical library.

It is a review of the world's literature dealing with iron and copper alloys and is well arranged in 12 chapters covering every aspect of the subject. Each chapter concludes with a summary, and it is refreshing to find that in every case in not more than 500 to 1,000 words, the authors give an accurate and unbiased *résumé* which enables one to gather the contents of the preceding chapter at a glance.

In view of the useful properties of many iron and copper alloys, it is rather astonishing to read that in the United States of America only about 2,000 tons, and in Germany 500 tons of copper are used annually in iron and steel. The advent of this present publication will, however, doubtless direct considerable attention to the possibilities of the addition of copper to iron and steels, and it will not be surprising if, as the result, the demands by the ferrous industry for copper increase considerably.

After an introductory chapter, the authors deal in two chapters with the constitution of iron-copper and iron-copper-carbon alloys. The binary equilibrium diagram has been worked out more or less thoroughly, and a composite equilibrium diagram based on the best information available is given. In view of the ease with which iron and copper alloys can be produced, it is, however, rather surprising that several points still remain to be ascertained. The iron-copper-cementite diagram is not given, as the authors point out that few, if any, of the significant surfaces or even lines have been accurately located.

The fourth and fifth chapters deal very fully with the melting and working of copper irons and steels and with the effect of copper on the physical properties of iron and steel.

Of particular interest to all metallurgists is Chapter VI, dealing with precipitation hardening of copper steels. Precipitation hardening is now an important branch of metallurgy, and although this present work is only a monograph dealing with iron and copper alloys, this particular chapter is in a way a complete introduction, if not more than an introduction, to the technique of precipitation hardening.

Chapters VII to X inclusive are of particular interest to engineers, as they contain all the available information concerning the effect of copper on the mechanical and corrosion-resisting properties of copper steels and irons. Chapter X, dealing with the effect of copper in cast iron, is also of great interest to the foundry trade.

The book concludes with a bibliography of 399 references, commencing with reference to a publication of 1627 dealing with the action of copper on iron, followed by reference to Stodart and Faraday's "Experiments on the Alloys of Steel made with a view to its Improvement" of 1820.

As previously mentioned, this is the fourth monograph of the series, and in the interests of metallurgy in general, and of the metallurgy of iron and steel in particular, it is to be hoped that the demand for it will be sufficiently great to ensure the early publication of the remaining six volumes which are already in course of preparation.

In view of the enormous amount of work which the preparation of such a work as this entails,

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Heat-Resisting Alloys

One of the principal lines of development in the design and construction of electric furnaces in recent years has been the production of metallic heating elements able to withstand without deterioration temperatures of the order of 1,350 deg. C. for use in furnaces for the heat-treatment of high-grade special steels and ceramic products. The results of the extensive research which has been carried out on these alloys is summarised by GRUNERT, HESSENBRUCH and SCHICHTEL in "Elektrowärme," principal attention being given to Cr-Al-Fe alloys containing from 20 to 30 per cent. of Cr and 3 to 7 per cent. Al, these alloys being primarily used for resistance units in high-temperature furnaces. The authors described experiments which show the effect of the Cr and Al contents on the resistance to heat as well as the influence exercised by the presence of carbon, phosphorus, cobalt, nickel and sulphur. These investigations demonstrated that as the C content increases, the life and heat-resistance are diminished, while phosphorus and sulphur have no deleterious effect. Contrary to various claims, the addition of cobalt was found to produce neither an increased resistance to heat nor an increase in melting point. On the other hand, nickel adversely affects the machinability.

As these elements exhibit a marked tendency to oxidise, they must be melted in a vacuum furnace. The question of oxidation is also important in regard to the mechanical resistance of the material. The physical properties of the Al-alloys differ somewhat from those of the Cr-Ni-alloys; thus the rigidity of the former is about 25 per cent. lower than that of the latter, a factor of importance in the design of the heating elements. When coiling these elements from Cr-Al-Fe-alloys, a certain ratio must be maintained between the diameter of the wire and the finished diameter of the coil. Winding must also be done between 400 and 700 deg.

Vitreous Enamelling Plant Conduct

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enamellers constructed and operated a model installation they would be surprised by the results obtained when using the proper sizes of steel grit.

Pressure and Distortion

MR. W. TODD, proposing a vote of thanks to Mr. Gray for his very able Paper, said that it covered a field which was worthy of a series of lectures; even the one subject of the use of steel abrasives would be productive of fruitful discussion for several hours.

Mr. Todd added that, from his experience, he was in whole-hearted agreement with the remarks of Mr. Rosenberger. Some three years ago his company had changed over to the use of angular steel abrasives, and he was convinced that that represented a step in the right direction; he would not consider under any circumstances a return to the use of flint sand. He agreed also with Mr. Gray, junr., that the application of excessive pressure would definitely cause distortion of steel sheets, and he was prepared to show Mr. Hill some definite results, irrespective of the size of grit used. He was not yet convinced that there might not be some physical changes in the iron, producing distortion; but whenever distortion troubles had arisen in the sand-blasting department it had been proved definitely that the distortion could be avoided by reducing the pressure, without effecting any change whatsoever in the size of grit used.

The vote of thanks was seconded by MR. REDMOND and carried unanimously.

The meeting then closed.

XUM

This Week's News in Brief

Trade Talk

THE GLENBOIG UNION FIRECLAY COMPANY, LIMITED, of Coatbridge, announce that they have secured an order for firebricks for the "Queen Mary's" boilers.

MESSRS. P. & M. HURLL, LIMITED, Gartliston Works, Glenboig, have received a repeat order from a Canadian iron and steel corporation. The contract is for almost 200,000 square bricks and thousands of fireclay bricks

AT A SOCIAL GATHERING of the employees of Messrs. R. & A. Main, Limited, Gothic Iron Works, Falkirk, Mrs. A. Cockburn, wife of the manager, presented them with a handsome pianoforte. Those present represented the numerous social and sports organisations of the firm.

A COMPANY OF ABOUT 120 members of the staff and friends of the Muirhall Foundry, Falkirk, held their social evening last week, over which Mr. Robert Taylor presided. In the course of his remarks, Mr. Taylor, who welcomed the guests, made fitting reference to the death of the late Mr. George Ure.

AS A RESULT OF NEGOTIATIONS undertaken by the Australian Association of British Manufacturers, the British preferential tariff on piston rings has been reduced from 4d. each, or 45 per cent., to 25 per cent. The secretary of the British Council is located at Australia House, Strand, London, W.C.2.

ENNISCORTHY URBAN COUNCIL has received a resolution from the local branch of the Irish Transport and General Workers' Union, calling on that body to obtain their future supplies of grates, fireplaces, etc., from the local foundry at St. Johns. Hitherto these commodities were purchased in Dublin.

THE STAFF AND FRIENDS of Messrs. Mitchell, Russell & Company, Limited, Chattan Foundry, Bonnybridge, held their annual whist drive and dance last Friday. Mr. James Mitchell, managing director, and Mr. Alex. Mitchell gave the whist prizes, which were presented by Mrs. James Mitchell.

THE MEEHANITE METAL CORPORATION OF AMERICA announces that the following foundries have now taken out licences to manufacture all grades of Meehanite metal:—Warren Foundry & Pipe Company, Phillipsburg, N.J.; the Wehrle Company, Newark, Ohio; Florence Pipe Foundry & Machine Company, Philadelphia, Pa.

THE ADMIRALTY has placed an order with Sir William Arrol & Company, Limited, Glasgow, for a large caisson, one of the largest ordered for many years, for the dock entrance to Singapore Dock. The contract covers the construction of the caisson, complete with electrically-operated hauling machinery and deck-lifting machinery.

THE ANNUAL DINNER of the Manchester Association of Engineers will be held at the Manchester Limited Restaurant, Royal Exchange, on Friday, March 1. Ladies are invited, and the dinner will be followed by a dance. Tickets, which cost 8s. 6d. per person, may be obtained from the secretary, Mr. T. Makemson, Saint John Street Chambers, Deansgate, Manchester.

THE DUNDEE, PERTH & LONDON SHIPPING COMPANY, LIMITED, have placed an order with the Caledon Shipbuilding & Engineering Company, Limited, Dundee, for a motor coaster for their general coasting trade. The new vessel will be 175 ft. long, and will be built to Lloyd's A1 class. She is to be specially designed for coastal and inland water traffic, and will have a deadweight carrying capacity of about 600 tons on a draft of 10 ft. Her service speed will be 10 knots.

SUBJECT TO THE SETTLEMENT of certain points of detail, the Admiralty has decided to place the order for the two coastal sloops of the 1934 building programme with Messrs. Alexander Stephen & Sons, Limited, Linthouse, Glasgow. The projected vessels —H.M.S. "Mallard" and H.M.S. "Puffin"—will, it is understood, be of the Kingfisher class, the first of which, H.M.S. "Kingfisher," was launched last week by the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow.

A NEW COMPANY is being formed in the Free State under the title of Irish Metal Industries, Limited, with a capital of £30,000, for the manufacture chiefly of sporting ammunition and the drawing of light-gauge non-ferrous metal tubes. Imperial Chemical Industries are stated to be interested in the concern, which is now busily engaged in the erection of works at Galway. The aim of the new company will be to make the country self-supporting in the manufacture of the particular commodities.

THE GOODWILL, PLANT, MACHINERY and all connected with the business carried on by Messrs. Hugh Smith & Company, Limited, at Possil Engine Works, Glasgow, together with well-equipped engineering works, consisting of main engineering shop, patternmakers' shop, pattern store, engineers' store, offices, caretakers' house, etc., are for immediate sale as a going concern. The works are convenient to the railway, and the site covers an area of 10,517 square yards. The floor area in the main shop is 36,000 square feet, and the street frontage is 275 feet.

MESSRS. ALEXANDER BROWN & SONS, a well-known Londonderry firm of ironfounders, and one of the oldest concerns in Ireland, are opening a foundry in the town of Letterkenny, County Donegal. A lease has been secured from the local Urban Council for the use of the disused gasworks for the purpose, and work will be commenced almost immediately. It is expected that about 50 hands will find regular employment. Londonderry, the headquarters of the parent firm, is located in Northern Ireland, and the object of the branch in Donegal, a Free State county, is to supply the requirements of that area direct and thus avoid the present tariff restrictions. Messrs. Brown will be able to import their iron and steel requirements direct through County Donegal ports.

IN ORDER to protect the village blacksmiths throughout the country, the Irish Free State Government has imposed a Customs duty of 33⅓ per cent. *ad valorem* on certain imported articles made wholly or mainly of iron or steel, or a combination of both. The new order applies to hooks, brackets, bands and similar fittings for supporting or securing in position gutters, rain pipes, smoke pipes, ventilation pipes and similar pipes; holdfasts or wall hooks not less than 4 in. in length; scythe mountings; hook and eye hinges imported complete, of which the eye part is not less than 12 in. in length; eye parts of hook and eye hinges, imported separately, of a length of not less than 12 in.; hook, parts of hook and eye hinges, imported separately, of a length of not less than 1 in.

Contracts Open

Doncaster, February 25.—Cast-iron water pipes and special castings, for the Water Department. The Water Engineer, 2, Priory Place, Doncaster.

New Zealand, March 19.—5-ton hand-operated overhead travelling crane, for the Public Works Department. The Department of Overseas Trade. (Reference A.Y. 12,924.)

Egypt, March 11.—Overhead travelling crane, 5 tons capacity, for the Egyptian Public Works Ministry, Tanzim Department. The Department of Overseas Trade. (Reference A.Y. 12,922.)

Omagh.—1,500 yds. 4-in. dia. and 400 yds. 8-in. dia. cast-iron pipes, class B, also special cast-iron connections, for the Urban District Council. Mr. W. Tallentire, Gas Office, Lurgan, Co. Armagh.

London, February 27.—Cast and spun iron straight pipes and cast-iron specials, sluice valves, for the Metropolitan Water Board. The Chief Engineer, the Offices of the Board (Room 155), 173, Rosebery Avenue, E.C.1.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Unique Metal Goods, Limited.—Capital £3,000. Ironfounders, manufacturers of agricultural implements, etc. Directors: M. J. Abraham, 45, Glenmore Road, Belsize Park, N.W.3; F. K. A. Hartmann, E. M. Speyer and E. C. Randall.

Parlanti's Art Foundry, Limited.—Capital £500 in £1 shares. To carry on the business of metal founders and manufacturers, etc. Directors: E. J. Parlanti, 62, Hurlingham Road, S.W.6.; Eileen D. Kirby, 1a, Duke Street, Manchester Square, W.1; W. H. Webber, 9, Golden Square, W.1.

Personal

MR. ROBERT HASWELL, who has been associated with Messrs. William Doxford & Sons, Limited, shipbuilders, Sunderland, for 56 years, has been appointed managing director in succession to the late Mr. Charles D. Doxford.

MR. WALTER G. RICHARDS, chairman and managing director of Messrs. W. Richards & Sons, Limited, Dinsdale Moor Ironworks, Middleton St. George, and Britannia Foundry, Middlesbrough, has been elected a Fellow of the North-East Coast Institution of Engineers and Shipbuilders. He has been twice chairman of the Tees-side Branch of the Institution, has been a member of the Council for six years, and three years ago became a Vice-President.

Wills

WILLCOCKS, JOHN, of Newton Abbot (Devon), engineer and ironfounder ...	£12,008
DAGLISH, HARRY BOLTON, of Forest House, Liverpool Road, Prescot, foundry owner	£91,331
ROWELL, JOHN, joint managing director of the Projectile & Engineering Company, Limited	£11,016
SANKEY, G. H., managing director of Messrs. Joseph Sankey & Sons, Limited, of Bilston, etc., and a director of Messrs. John Lysaght, Limited, and Harris & Sheldon, Limited	£40,432

Obituary

MR. WILLIAM BURTON, J.P., former manager and director of the Wigan Rolling Mills, died recently at the age of 92.

MR. FREDERICK CHARLES DEMAINE, foundry manager with the firm of Messrs. Buckley & Taylor, Limited, engineers, Oldham, died recently.

MR. EWART DIGHT GERRARD, a director of the North British Locomotive Company, Limited, Glasgow, died last week. Mr. Gerrard joined the firm in his youth as a draughtsman. About a year ago he became a member of the board and was one of the technical directors, having charge of the drawing office.

Forthcoming Events

FEBRUARY 22.

Manchester Association of Engineers:—"Some Aspects of Budgetary Control," Paper by C. G. Renold at the Engineers' Club, Albert Square, Manchester, at 7.15 p.m.

The Institute of British Foundrymen

FEBRUARY 22.

Middlesbrough Branch:—"The Dagenham Foundry of the Ford Motor Company, Limited," Paper by Vincent C. Faulkner and J. N. Burns at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

FEBRUARY 23.

Newcastle-upon-Tyne Branch:—"The Making of Castings for Internal-Combustion Engines," Paper by A. L. Key at the Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

Scottish Branch:—"Refractories in the Foundry," Paper by H. C. Biggs at the Heriot-Watt College, Chambers Street, Edinburgh, at 4 p.m.

East Midlands Branch:—"Bells: Their History and Manufacture," Paper at the Loughborough College, Loughborough, at 6 p.m.

FEBRUARY 27.

Lancashire Branch:—"How Welding has Displaced Castings in Manufacture by Fabrication," Paper by J. Sadler, to be read at a joint meeting with the North-Western Branch of the Institution of Welding Engineers at the College of Technology, Sackville Street, Manchester, at 7 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 25.

Birmingham:—"Cast Iron for Vitreous Enamelling," Paper by J. W. Gardom at the Chamber of Commerce, New Street, Birmingham, at 7.30 p.m.

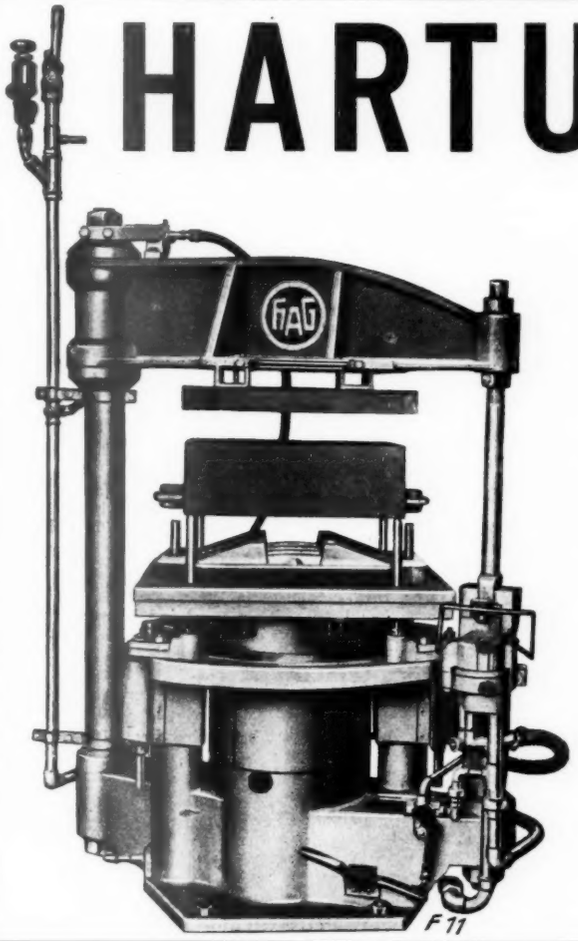
FEBRUARY 28.

London:—(1) "Silicosis," Paper by E. L. Middleton, M.D., D.P.H., H.M. Inspector of Factories; (2) "Silicosis: The Minerals which Cause It," Paper by W. R. Jones, D.Sc. (Lond.), F.G.S., M.I.M.M. Council Chamber, British Industries House, Marble Arch, London, W.1, at 8 p.m.

XUM

HARTUNG

MOULDING MACHINES for High-Speed Production



Our TYPE "RECORD"

An improved type of Moulding Machine, which Jolts, Squeezes, and on the downward stroke of the Table Plate, after Squeezing, automatically draws the pattern from the Moulding Box. Pneumatically operated throughout at Air Pressure 80 lbs. to 90 lbs. per sq. inch.

HARTUNG A.-G.

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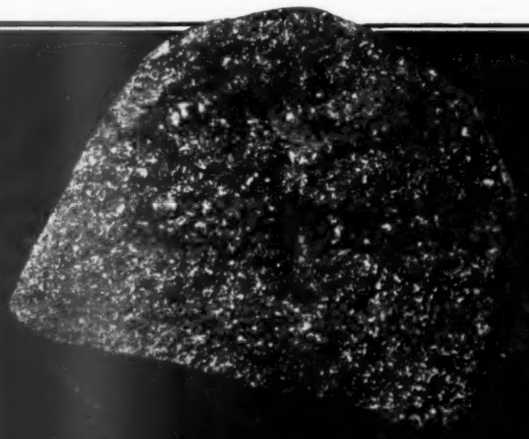
Come to see our Exhibits at the Leipzig Spring Fair, 3-10 March, 1935, HALL 8 - - STAND 25/42

DORMAN LONG



Manufacturers of FOUNDRY, BASIC and HEMATITE qualities. Delivery from stock. Booklet giving analyses, etc., will be sent on request.

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MIDDLESBROUGH

AGENTS IN SCOTLAND:
MESSRS. J. & A. McMORLAND,
40 ST. ENOCH SQUARE, GLASGOW

PIG IRON

Raw Material Markets

Broadly speaking, although there has been a slight check in business in the iron and steel markets, there has been no loss of confidence in the outlook. The steelmakers still have plenty of orders on their books, and the heavy demand for pig-iron is sufficient to absorb practically the entire current output. Activity in certain sections of the foundry industry is still below normal, but the lull is generally expected to be of a temporary nature only. The foundries chiefly affected are those connected with the building trade, which should shortly feel the stimulus of Government-subsidised housing schemes.

Pig-Iron

MIDDLESBROUGH.—The general feeling on the Cleveland iron market is one of quiet confidence. Producers find that the steady demand against existing contracts enables them to dispose of their output without taking more than insignificant quantities of iron into stock, and they are now negotiating contracts covering the third quarter. Prospects in the local foundry trade are quite good at the moment. Home prices are unaltered, fixed minimum quotations for No. 3 Cleveland G.M.B. being 67s. 6d. per ton delivered Middlesbrough, 69s. 6d. delivered North-East Coast, 67s. 3d. delivered Falkirk and 70s. 3d. delivered Glasgow. No. 1 foundry iron is at a premium of 2s. 6d. per ton and No. 4 foundry and No. 4 forge iron are both charged 1s. per ton less than No. 3.

Current sales of East-Coast hematite are on a satisfactory scale, and these, in addition to heavy contract commitments, place the makers in a strong position, although as yet the demand is not such as to justify the lighting of additional furnaces. Foreign business is quiet, but further sales to Italy are being negotiated, and another big shipment of ferro-manganese has just been despatched to Australia. Fixed delivered prices of No. 1 East-Coast hematite in the various zones are:—Middlesbrough, 69s. per ton; North-East Coast, 71s.; Scotland, 75s.; Lancashire, 76s.; Yorkshire, 75s. to 78s.; Birmingham, 79s. per ton.

LANCASHIRE.—The Midlands ironmasters report that business with consumers in this area has been nothing out of the ordinary during the past fortnight, apart from one or two replacement contracts. Conditions continue to vary considerably in the various sections of the foundry industry, and from one works to another. Generally speaking, however, machine-tool makers and heavy electrical engineers are quite busy. Conditions in the textile machinery industry have yet to improve. The general price position remains extremely steady. For delivery to foundries in the Lancashire price zone, Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire are all quoted on the basis of 74s. per ton, with Northamptonshire at 72s. 6d., Scottish foundry iron at from about 81s. 6d. to 82s. 6d., West Coast hematite at around 78s. 6d., and East Coast at from 75s. to 76s., according to grade.

MIDLANDS.—The position of the light-castings trade in this area leaves something to be desired, more particularly as regards the larger concerns, as orders for builders' castings have been of a limited nature for some time. For Midland brands of ordinary foundry iron the controlled prices delivered Birmingham and Black Country stations are 67s. 6d. for Northants No. 3 and 71s. for Derbyshire, Staffordshire and Lincolnshire No. 3. Fairly substantial quantities of iron other than the common grades are going into consumption at the jobbing and general engineering foundries. The prices of these irons vary considerably. Medium-phosphorus pig-iron is offered at 72s. to 80s. per ton, Scottish and other low-phosphorus irons at 85s. to 87s. 6d., and refined iron at upwards of £5 7s. 6d. per ton delivered this district. Hematite prices are very firm. West Coast iron is controlled at 84s. 6d., and East Coast and Welsh hematites are offered at 78s. per ton delivered here.

SCOTLAND.—The demand for Scottish foundry iron on the Glasgow market is still of a rather unsatisfactory nature. There is no change to report in prices. The makers adhere to the official minimum of 70s. for No. 3 foundry f.o.t. furnaces with 2s. 6d. per ton extra for No. 1. The light-castings trade continues to be well employed, and to take regular supplies of iron from England, in addition to what is bought from the local blast furnaces. No. 3 Cleveland is still quoted at 67s. 3d. at Falkirk and 70s. 3d. at Glasgow. Other English foundry iron is quoted at 1s. 3d. per ton below these figures.

Coke

Buying of foundry coke is not very active at the moment, many consumers being already contracted. Quotations for delivery to Midland stations remain as follow:—Best Durham, 36s. to 40s.; Welsh coke, 34s. to 45s.; Scottish low-ash coke, about 40s. per ton for small lots.

Steel

Steady conditions rule in the steel trade, and there has been a recovery in the volume of business, which suffered a slight setback recently owing to the disturbed position of other commodity markets, states the official report of the London Iron and Steel Exchange. The market for semi-finished steel has developed activity, following a period of poor trading. Owing to the possibility of the duties upon steel being increased, comparatively little business has been transacted in Continental semis, and a considerable tonnage of orders has been taken by the British makers. Many consumers, however, are carrying stocks, and are inclined to hold aloof from the market for the time being. Most of the producers of finished steel have good order-books and are making heavy deliveries to the consuming trades. The demand seems to be spread unevenly over the market and some branches are experiencing rather quiet conditions. In general, however, there is a tendency for home trade business to expand. The export inquiry is on a good scale, and the recent improvement in this department has been maintained.

Scrap

The demand for scrap iron is well maintained in the Cleveland district, where merchants are now asking up to 55s. per ton for good machinery quality and 53s. 6d. for ordinary heavy cast iron. In the Midlands, heavy machinery metal broken into cupola sizes is at 55s., good heavy at 50s. and clean light at 47s. 6d. Business in scrap iron in South Wales is of a limited nature; heavy material in large pieces and furnace sizes is at 50s. to 52s. 6d., light cast-iron scrap at 40s. to 42s. 6d., and good cast-iron machinery scrap in foundry sizes at 52s. 6d. to 55s. The inquiry for cast-iron scrap in Scotland is reported to have fallen away slightly. Heavy machinery grade is quoted at 55s. to 56s., with ordinary cast-iron scrap to the same specification 51s. 6d.

Metals

Copper.—The copper market has shown a hesitant tone lately, although, now that the United States Supreme Court has come to a favourable decision on the question of the "gold clause," a more confident feeling should become apparent. There is a steady demand for copper from consumers in this country, conditions in this respect showing very little change. Negotiations are still proceeding for a world agreement on the restriction of copper output, and it is believed that further conversations between producers will take place shortly in New York.

Daily quotations :—

Cash.—Thursday, £27 5s. to £27 6s. 3d.; Friday, £27 5s. to £27 6s. 3d.; Monday, £27 5s. to £27 6s. 3d.; Tuesday, £27 10s. to £27 11s. 3d.; Wednesday, £27 3s. 9d. to £27 5s.

Three Months. — Thursday, £27 10s. to £27 11s. 3d.; Friday, £27 10s. to £27 11s. 3d.; Monday, £27 10s. to £27 11s. 3d.; Tuesday, £27 15s. to £27 16s. 3d.; Wednesday, £27 10s. to £27 11s. 3d.

Tin.—A stronger tone is now apparent in this market, but the ground lost during the recent fall in prices has not yet been regained. The supply position on the London market is slightly easier, larger quantities of Dutch tin being available.

"Trade demand has been rather quieter in this country, as also on the Continent, buyers having displayed some reserve, no doubt influenced by the recent unsettlement. In the U.S.A., consumption is reported to be fairly well maintained, but here also actual demand has been light, with buyers apparently content to satisfy only their immediate requirements," report Messrs. Rudolf Wolff.

Market fluctuations :—

Cash.—Thursday, £227 10s. to £227 15s.; Friday, £228 5s. to £228 10s.; Monday, £229 10s. to £230; Tuesday, £229 10s. to £229 15s.; Wednesday, £228 17s. 6d. to £229.

Three Months.—Thursday, £223 15s. to £224; Friday, £224 15s. to £225; Monday, £225 10s. to £225 15s.; Tuesday, £225 15s. to £226; Wednesday, £224 10s. to £224 15s.

Spelter.—The result of the investigation by the Import Duties Advisory Committee into the position of the spelter and lead markets, more particularly as the result of the 10 per cent. *ad valorem* duty on foreign metal, is anxiously awaited. It is believed that the Committee has now concluded its hearing of evidence. In the meantime, the uncertainty has tended to keep consumers from entering into forward purchases.

Official quotations :—

Ordinary.—Thursday, £11 18s. 9d.; Friday, £11 18s. 9d.; Monday, £12 2s. 6d.; Tuesday, £12; Wednesday, £11 16s. 3d.

Lead.—In spite of the disturbing effect of the tariff inquiry, referred to under "Spelter," there has been quite a good industrial demand for lead, and prospects of increased activity in the consuming trades are reasonably good.

Day-to-day prices :—

Soft Foreign (Prompt).—Thursday, £10 3s. 9d.; Friday, £10 3s. 9d.; Monday, £10 3s. 9d.; Tuesday, £10 3s. 9d.; Wednesday, £10 5s.

Catalogues Received

Welding Electrodes. Bearing the caption "The Man in the Mask," a booklet issued by the Metropolitan-Vickers Electrical Company, Limited, of Trafford Park, Manchester, 17, has several interesting features. There is, for instance, a welder's mask attached to the cover, complete with window, through which an interior illustration can be seen. A second feature is the repeated appearance of a particularly happy-looking welder who makes all the selling points. Our readers will be interested in page 8, where a standard argument for the replacement of castings by weldings is outlined, opposite a picture of a built-up bedplate—a really excellent piece of work. The smartness of this booklet is that its real purpose is as cleverly "masked" as its principal character.

Pulley Blocks. Felco Hoists, Limited, of 15, Victoria Street, London, S.W.1, have sent us an advance copy of a new 20-page well-illustrated catalogue they have prepared, which covers triple-gear chain blocks, travelling trolleys and chain blocks, rope pulley hoists and a novel loader for vehicles. This last-named arrangement consists of a H-beam from which is suspended a triple-gear chain block. Apparently, this beam can be easily shifted to cover the lorry floor diagonally and centrally along its length, or, again, along the side, so as to allow for loading by overhead crane. As, normally, castings constitute a rather heavy load, a system of this character presents features of distinct interest to the foundry industry, and, on this count alone, we suggest that our readers would be well advised to acquaint themselves with the system.

AN OBVIOUS ERROR has appeared in recent advertisements of Bonvillain and Ronceray's B.M.C. sand-rubbing machine (Universal System of Machine Moulding & Machinery Company, Limited, of 1A, St. Leonard's Road, East Sheen, London, S.W.14), wherein the word "impermeability" instead of "permeability" was used.

ARMSTRONG WHITWORTH
Rotary Air GRINDERS

Armstrong Whitworth Rotary Air Grinders have proved by reliable and efficient service that they produce a better job in less time. They are now being used extensively in iron and steel foundries, both in this country and abroad. We offer a comprehensive range of sizes, to suit all requirements, direct from stock.

A fully illustrated catalogue will be sent to you with pleasure on request.

245 Rotary Air Grinder at work on Steel Runner Wheel Casting.

ARMSTRONG WHITWORTH
SCOTSWOOD WORKS — Sir W. G. Armstrong Whitworth & Co. (Engineers) Limited — NEWCASTLE upon TYNE

London Office: Thames House, Westminster, S.W.1.

CAST IRON FLANGED PIPES
2 in.—12 in. & CONNECTIONS. to 24 in. dia.
WE HAVE FIFTY-TWO YEARS OF ACCUMULATED EXPERIENCE AND METAL PATTERNS.
JAMES & RONALD RITCHIE, LTD.,
Telephone: 3852 (2 Lines). MIDDLESBROUGH. Telegrams: "Ritchie, Middlesbrough."

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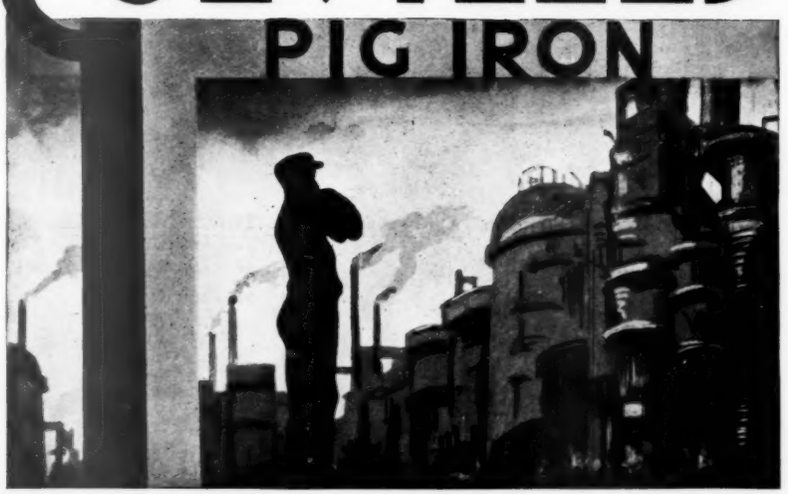
PIG IRON



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DALZELL, GLENGARNOCK CLYDE & MONKLAND

HIGH GRADE HEMATITE PIG IRON

SPECIAL & ORDINARY FOUNDRY QUALITIES & FORGE

SPECIAL REFINED WITH TOTAL CARBON GUARANTEED NOT EXCEEDING 3% MAX.

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Write for our Illustrated Booklet

RAW MATERIALS—PRICE LIST

(Wednesday, February 20, 1935)

COPPER

	£	s.	d.
Standard cash	27	3	9
Three months	27	10	0
Electrolytic	30	10	0
Tough	29	0	0
Best selected	29	10	0
Sheets	58	0	0
India	41	0	0
Wire bars	30	12	6
Ingot bars	30	12	6
H.C. wire rods	33	10	0
Off. av. cash, January	28	2	2 1/16
Do., 3 mths., January	28	9	5 19/22
Do., Sttlmnt., January	28	2	4 7/11
Do., Electro, January	31	9	1 1/11
Do., B.S., January	31	2	6
Do., wire bars, January	31	12	11 5/11
Solid drawn tubes			9½d.
Brazed tubes			9½d.
Wire			6d.

BRASS

Solid drawn tubes	
Brazed tubes	8¾d.
Rods, drawn	10¾d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	4½d.
Wire	7½d.
Rolled metal	7d.
Yellow metal rods	6⅝d.
Do. 4 × 4 Squares	4¼d.
Do. 4 × 3 Sheets	5¼d.
	5½d.

TIN

	£	s.	d.
Standard cash	228	17	6
Three months	224	10	0
English	229	5	0
Bars	231	5	0
Straits (nom.)	229	5	0
Australian (nom.)	—		
Eastern	229	0	0
Banca (nom.)	232	10	0
Off. av. cash, January	231	6	0 3/11
Do., 3 mths., January	228	16	9 9/11
Do., Sttlmt., January	231	6	4 5/11

SPELTER

	£	s.	d.
Ordinary	11	16	3
Remelted	13	5	0
Hard	10	15	0
Electro 99.9	14	10	0
English	13	2	6
India	12	10	0
Zinc dust	17	0	0
Zinc ashes	3	0	0
Off. aver., January	12	2	0 9/44
Aver. spot, January	11	19	10 1/11

LEAD

	£	s.	d.
Soft foreign ppt.	10	5	0
Empire (nom.)	11	3	9
English	12	5	0
Off. average, January	10	8	4 5/22
Average spot, January	10	6	5 1/22

ALUMINIUM

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	23	0	0
Do., V.M. ex-whse.	22	10	0
Rods	26	10	0

ANTIMONY

	£	s.	d.
English	77	0	0 to 78 0 0
Chinese, ex-whse.	69	10	0
Crude	—		

QUICKSILVER

	£	s.	d.
Quicksilver	11	2	6 to 11 12 6

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	8	17	6
45/50%	12	10	0
75%	17	19	6
Ferro-vanadium—			
35/50	12/8 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	4/6 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£14	10	0
Ferro-tungsten—			
80/85%	3/- lb.		
Tungsten metal powder—			
98/99%	3/3 lb.		
Ferro-chrome—			
2/4% car.	29	15	0
4/6% car.	23	0	0
6/8% car.	21	12	6
8/10% car.	21	12	6
Ferro-chrome—			
Max. 2% car.	34	0	0
Max. 1% car.	38	15	0
Max. 0.70% car.	42	0	0
70% carbon-free	10d. lb.		
Nickel—99.5/100%	£200 to £205		
"F" nickel shot	£184	0	0
Ferro-cobalt, 98/99%	5/3 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11 5 0		
76/80% packed	£11 15 0 to £12 5 0		
76/80% export (nom.)	£9 15 0		
Metallic manganese—			
94/96% carbon-free	1/2 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 5/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel	2	15	0 to	2	16	0
Bundled shrngs.				2	7	6
Mixed iron and steel	2	10	0 to	2	12	0
Heavy cast iron	2	10	0 to	2	12	6
Good machinery	2	12	6 to	2	15	0
Cleveland—						
Heavy steel						
Steel turnings				2	11	9
Cast-iron borings				1	15	0
Heavy cast iron				1	5	0
Heavy machinery				2	13	6
				2	15	0
Midlands—						
Light cast-iron scrap				2	7	6
Heavy wrought iron				3	0	0
Steel turnings, f.o.r.				1	15	0
Scotland—						
Heavy steel						
Ordinary cast iron				2	10	0
Engineers' turnings				2	11	6
Cast-iron borings				1	19	0
Wrought-iron piling				1	19	0
Heavy machinery	2	15	0 to	2	12	6
				2	16	0

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	25	0	0
Brass	16	10	0
Lead (less usual draft)	9	10	0
Tea lead	6	10	0
Zinc	8	0	0
New aluminium cuttings	66	0	0
Braziery copper	20	0	0
Gunmetal	23	0	0
Hollow pewter	160	0	0
Shaped black pewter	118	0	0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	70/-
Foundry No. 3	67/6
,, at Falkirk	67/3
,, at Glasgow	70/3
Foundry No. 4	66/6
Forge No. 4	66/6
Hematite No. 1	69/-
Hematite M/Nos.	68/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	67/-
,, No. 3 fdry.	71/-
Northants forge	63/6
,, fdry. No. 3	67/6
,, fdry. No. 1	70/6
Derbyshire forge	67/-
,, fdry. No. 3	71/-
,, fdry. No. 1	74/-
Scotland—	
Foundry No. 1, f.o.t.	72/6
,, No. 3, f.o.t.	70/-
Hem. M/Nos. d/d	71/-
Sheffield (d/d district)—	
Derby forge	64/6
,, fdry. No. 3	68/6
Lincs forge	64/6
,, fdry. No. 3	68/6
E.C. hematite	81/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	
Staffs fdry. No. 3	74/-
Northants fdry. No. 3	74/-
Cleveland fdry. No. 3	72/6
Dalzell, No. 3 (special)	74/-
Glengarnock, No. 3	102/6 to 105/-
Clyde, No. 3	82/-
Monkland, No. 3	82/-
Summerlee, No. 3	82/-
Eglinton, No. 3	82/-
Gartsherrie, No. 3	82/-
Shotts, No. 3	82/-

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	12	6 to	9	15	0
Nut and bolt iron	7	10	0 to	8	0	0
Hoops	10	10	0 and up.			
Marked bars (Staffs) f.o.t.	12	0	0			
Gas strip	10	10	0 and up.			
Bolts and nuts, ¾ in. × 4 in.	14	2	6 and up.			
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.	9	5	0 to	9	7	6
Chequer plts.	10	7	6			
Angles	8	7	6			
Tees	9	7	6			
Joists	8	15	0			
Rounds and squares, 3 in. to 5½ in.	9	7	6			
Rounds under 3 in. to ⅝ in. (Untested)	8	12	0			
Flats—8 in. wide and over	8	12	6			
,, under 8 in. and over 5 in.	8	17	6			
Rails, heavy	8	5	0 to	8	10	0
Fishplates	12	5	0 to	12	10	0
Hoops (Staffs)	9	7	0			
Black sheets, 24g. (4-t. lots)	10	10	0			
Galv. cor. shts. (,,)	13	0	0			
Galv. flat shts. (,,)	13	10	0			
Galv. fencing wire, 8g. plain	14	10	0			
Billets, soft	5	10	0 and up.			
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	7	6
Tin bars	5	2	6 to	5	7	6

PHOSPHOR BRONZE

	Per lb. basis.
Strip	9d.
Sheet to 10 w.g.	10d.
Wire	11d.
Rods	10d.
Tubes	13d.
Castings	10⅝d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/1½ to 1/7½
To 21 in. wide	1/2 to 1/8
To 25 in. wide	1/2½ to 1/8½
Ingots for spoons and forks	1/3 to 1/9
Ingots rolled to spoon size	7d. to 1/3½
Wire round—	10d. to 1/6½
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	20.26
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.50
Basic, Valley	18.00
Bessemer	20.76
Malleable, Valley	18.50
Grey forge, Valley	18.00
Ferro-mang. 80%, seaboard	85.00
O.-h. rails, h'y, at mill	36.37½
Billets	27.00
Sheet bars	28.00
Wire rods	38.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.70
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.60
Plain wire	2.30
Barbed wire, galv.	3.00
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	25/- to 27/6
,, furnace	19/- to 20/-
Durham foundry	20/- to 25/-
,, furnace	17/6
Midlands, foundry	—
,, furnace	

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		18/2 to 19/2
,,	28×20	,,	36/4 to 38/4
,,	20×10	,,	26/- to 26/3
,,	18¾×14	,,	18/6 to 18/9
C.W.	20×14	,,	15/6 to 16/6
,,	28×20	,,	33/- to 33/6
,,	20×10	,,	23/- to 24/-
,,	18⅜×14	,,	16/- to 17/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£	s.	d.		
Feb. 14 ..	27	5	0	inc.	3/9
„ 15 ..	27	5	0	No	change
„ 18 ..	27	5	0	„	„
„ 19 ..	27	10	0	inc.	10/-
„ 20 ..	27	3	9	dec.	6/3

Electrolytic Copper

	£	s.	d.		
Feb. 14 ..	30	10	0	inc.	10/-
„ 15 ..	30	5	0	dec.	5/-
„ 18 ..	30	5	0	No	change
„ 19 ..	30	10	0	inc.	5/-
„ 20 ..	30	10	0	No	change

Standard Tin (cash)

	£	s.	d.		
Feb. 14 ..	227	10	0	dec.	35/-
„ 15 ..	228	5	0	inc.	15/-
„ 18 ..	229	10	0	„	25/-
„ 19 ..	229	10	0	No	change
„ 20 ..	228	17	6	dec.	12/6

Tin (English ingots)

	£	s.	d.		
Feb. 14 ..	227	17	6	dec.	32/6
„ 15 ..	228	12	6	inc.	15/-
„ 18 ..	229	17	6	„	25/-
„ 19 ..	229	17	6	No	change
„ 20 ..	229	5	0	dec.	12/6

Spelter (ordinary)

	£	s.	d.		
Feb. 14 ..	11	18	9	No	change
„ 15 ..	11	18	9	„	„
„ 18 ..	12	2	6	inc.	3/9
„ 19 ..	12	0	0	dec.	2/6
„ 20 ..	11	16	3	„	3/9

Spelter (Electro, 99.9 per cent.)

	£	s.	d.		
Feb. 14 ..	14	11	3	No	change
„ 15 ..	14	11	3	„	„
„ 18 ..	14	10	0	dec.	1/3
„ 19 ..	14	11	3	inc.	1/3
„ 20 ..	14	10	0	dec.	1/3

Zinc Sheets (English)

	£	s.	d.		
Feb. 14 ..	23	0	0	No	change
„ 15 ..	23	0	0	„	„
„ 18 ..	23	0	0	„	„
„ 19 ..	23	0	0	„	„
„ 20 ..	23	0	0	„	„

Lead (English)

	£	s.	d.		
Feb. 14 ..	12	10	0	No	change
„ 15 ..	12	10	0	„	„
„ 18 ..	12	5	0	dec.	5/-
„ 19 ..	12	5	0	No	change
„ 20 ..	12	5	0	„	„

Imports and Exports of Pig-Iron, Iron and Steel Castings, etc., in January, 1935, compared with January, 1933 and 1934

	January, 1933.	January, 1934.	January, 1935.	January, 1933.	January, 1934.	January, 1935.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pig-iron—from British India	7,726	10,012	5,067	21,141	27,326	14,946
„ Foreign Countries	719	2,149	2,361	4,327	12,775	14,680
Total	8,445	12,161	7,428	25,471	40,101	29,626
Castings and forgings	81	158	308	1,917	4,224	7,847
Cast pipes and fittings	171	108	59	3,433	4,549	2,995
Stoves, grates, etc.	55	64	90	5,872	5,422	6,173
Baths	237	707	446	6,232	17,107	12,534
Hollow-ware, all kinds	74	271	177	4,419	13,773	10,508
Exports.						
Pig-iron, forge	142	31	95	630	107	389
„ foundry	3,512	4,855	6,252	11,840	17,362	21,677
„ acid	2,757	3,364	4,878	8,694	10,336	15,547
„ basic	190	545	—	725	1,747	—
Total	6,601	8,795	11,225	21,889	29,552	37,613
Castings and forgings	143	310	444	5,358	12,370	16,603
Cast pipes and fittings, up to 6 in. diameter	3,163	4,373	4,787	38,366	56,674	51,745
„ „ „ over 6 in. „	2,406	3,183	3,738	16,910	26,404	26,630
Stoves, grates, etc.	460	747	797	22,155	38,599	38,338
Sanitary cisterns	217	298	316	6,581	8,366	8,520
Bedsteads, inc. tubes therefor	323	626	341	12,740	19,131	12,783
Cast hollow-ware	340	317	303	13,282	13,043	12,020

TN ORANGE

WINCHESTER HOUSE, OLD BROAD STREET, LONDON, E.C.2.
Telegrams:- "ALKALIZE, STOCK, LONDON" Phones:- LONDON WALL 7955 (5 LINES)

AC GARNET

FINE ORANGE

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WHITE

PALE LEMON

THE METAL EXCHANGE
Telegrams: "JACKS, METMA, LONDON" LONDON, E.C.3. Phone: LONDON WALL 7955

FINE WHITE

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

MALLEABLE and GREY IRONFOUNDRY GENERAL, COMMERCIAL or SALES MANAGER desires position with progressive company.—Apply, Box 166, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATTERN Equipment Designer or Pattern Lay-out Man desires position with British firm. Twelve years' foundry experience on all classes of automobile work. Familiar with the latest methods and equipment in both foundry and coreshop.—Box 150, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PIPE Pit Foreman required to take charge of three to four pits producing cast-iron pipes 3 in. to 6 in. dia.—Apply, stating full experience and wage required, to COCHRANE & COMPANY (WOODSIDE), LIMITED, Woodside Ironworks, Dudley.

WANTED, Foundry Foreman, experienced in the manufacture of heat-resisting and stainless castings. Practical training in moulding and foundry operations in alloy-steel castings essential.—State age and experience, and salary required, to Box 152, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Manager requires position; has had considerable experience in complete control, locomotive, railway and general engineering work. Iron, steel, non-ferrous and patternshop. (254)

METAL Patternmaker desires position as Charge over metal patternshop or progressive position attached to foundry. Accustomed to ferrous and non-ferrous casting production, modern methods. Technically trained in foundry practice and science, metallurgy, foundry calculations and making of working drawings. Age 29. (255)

PATENT

THE Proprietor of British Patent No. 362,715, dated May 17, 1930, relating to "Improvements in Making Semi-Finished or Finished Steel Products," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above Patent and ensuring its practical working in Great Britain.—Inquiries to B. SINGER, Steger Building, Chicago, Illinois.

MACHINERY

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

MACHINERY—*Continued.*

MOULDING MACHINES—
SPECIAL OFFER.

2 Osborn J75 Jolt Squeezers.
1 Osborn 406 Jolt Rollover.
1 Britannia No. 4 Jolt Rollover, 78 in. x 48 in.
1 Nicholls 18 x 42 Jolt Squeezer.
2 Macdonald 36 x 24 Jolt Rollovers.
2 Macdonald 58 x 52 Jolt Rollovers.
Ten Plain Jolters—various sizes.
Every Machine Re-tested.

ALEX. HAMMOND,
Foundry Machinery Merchant,
14, Australia Road, Slough.

PAIR of Selas Turner Gas-fired Melting Furnaces, re-lined. These could be used for either gas- or oil-firing. Offered cheaply.—Please write, ALEX. HAMMOND, Foundry Machinery Merchant, 14, Australia Road, Slough.

SAND BLASTS—SPECIAL OFFER.

12-ft. x 9-ft. Tilghman Room Plant.
8-ft. x 8-ft. Tilghman Room Plant.
6 ft. x 3-ft. x 3-ft. Tilghman Cabinet.
3-ft. x 3-ft. x 3-ft. Tilghman Cabinet.

ALEX. HAMMOND,
Foundry Machinery Merchant,
14, Australia Road, Slough.

SANDBLAST PLANTS

Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.

Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.

Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.

Most of the above by Tilghman and complete with Air Compressors.

HAND MOULDING MACHINES

By Adaptable, Pridmore, Darling & Sellars, etc.; Squeezers by Utard (unused), Samuelson and Britannia, also Farwell Universal Type.

Ladles, Grinding Machines, Exhaust Fans, Blowers, Air Compressors and 500 Electric Motors and Dynamos.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.

CROSSWELLS ROAD (Adjoining Railway Crossing), LANGLEY, Nr. Birmingham.
'Phone: Broadwell 1359.

THOS. W. WARD LTD.

New 24" "Ace" Vert. DRILLING MACHINE: 1¼" dia. spindle; 17" dia. table with 21" vert. adjust; belt-driven.

CENTRIFUGAL PUMP, 3½" dia. suc. and del. (Allen), dr. by Vert. Engine; 4" dia. cyl., 3" str.

New COCHRAN BOILER, 12' 3" x 5' 3", 100 lbs. w.p.

Write for "Albion" Catalogue.

'Grams: "Forward." 'Phone: 23001 (10 lines).

ALBION WORKS, SHEFFIELD.

MISCELLANEOUS

TO Foundries, Iron and Steel Works, etc.—Advertiser, with 15 years' experience in purchasing materials for above-mentioned works, wishes to enter into contracts with those firms requiring assistance or desirous of effecting economies on basis of Agency terms. Firms who become interested in the scheme will find great saving effected.—Write for interview, when terms and particulars can be discussed, to Box 160, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

'Phone: 4044.

J. BUTLER,

Pattern Maker to Engineering and Motor Trades.

PRIORY STREET, COVENTRY.

MISCELLANEOUS—*Continued*

FOR Sale, 20 nearly-new Hematite Foundry Loam Moulding Plates, 9 ft. x 8 ft. x 6 in. thick, 9-in. slots, approx. weight 5 tons each.—Box 168, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PLATE Moulding Table, practically new, size 5 ft. 9 in. x 3 ft. 9 in.; cost £138. Open to offer. Also Annealing Cans and Stools (New), sizes and weight as follow:—

24 Cans ea. 14 in. x 17 in.
24 Cans ea. 14 in. x 18 in.
Weight 5 tons 8 cwts.
25 Stools. Weight 1 ton 3 cwts.

Box 148, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. 'Phone 264.

CEYLON PLUMBAGO (in casks), Empire produce—direct import, always in stock.—Quotation and samples from WILLIAM OLSEN, LIMITED, Hull.

'Phone: 287 SLOUGH

MOULDING MACHINES

406 OSBORN jolt rollover.
18"×36" TABOR rollover shockless (portable).
40"×30" TABOR rollover shockless.
TWO BRITANNIA No. 1 jolters.

HAND Machines taken in part payment for above or exchanged.

EXTENDED PAYMENTS ARRANGED.

SANDBLAST PLANTS

12' × 9' Tilghman sandblast room, built of cast iron plates, complete with 400 cu. ft. Tilghman air compressor and all accessories.
T.B. 4 Tilghman sandblast barrel plant, complete. Size of barrel 60" × 40".
T.B. 1 Tilghman sandblast barrel.
Small Tilghman rotary table sandblast.

BUY FROM ME AND SAVE MONEY!

ALEX. HAMMOND, *Foundry Machinery Merchant,*
14, AUSTRALIA ROAD, SLOUGH

PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun and on occasions—be it admitted—of naughtiness.

Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception.

Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed.

There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d a year to you. Send Peter and his handicapped pals 3d for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,
SCHOOL FOR THE BLIND
(Founded 1838)
SWISS COTTAGE, LONDON, N.W.3